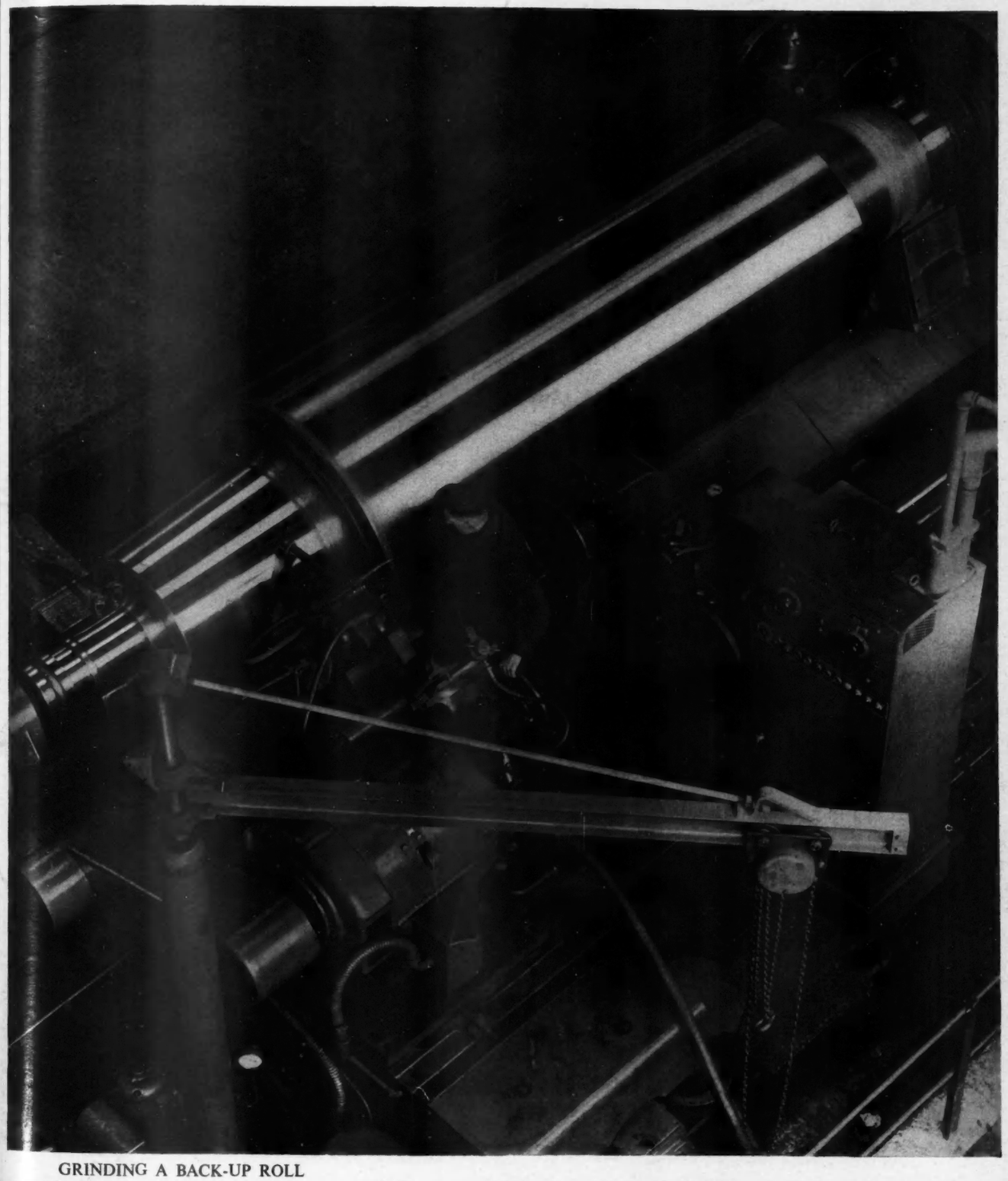
ENGINEERING

An Illustrated Weekly Journal

35 & 36 BEDFORD STREET, STRAND, LONDON, W.C.2 TELEPHONE: TEMPLE BAR 3663

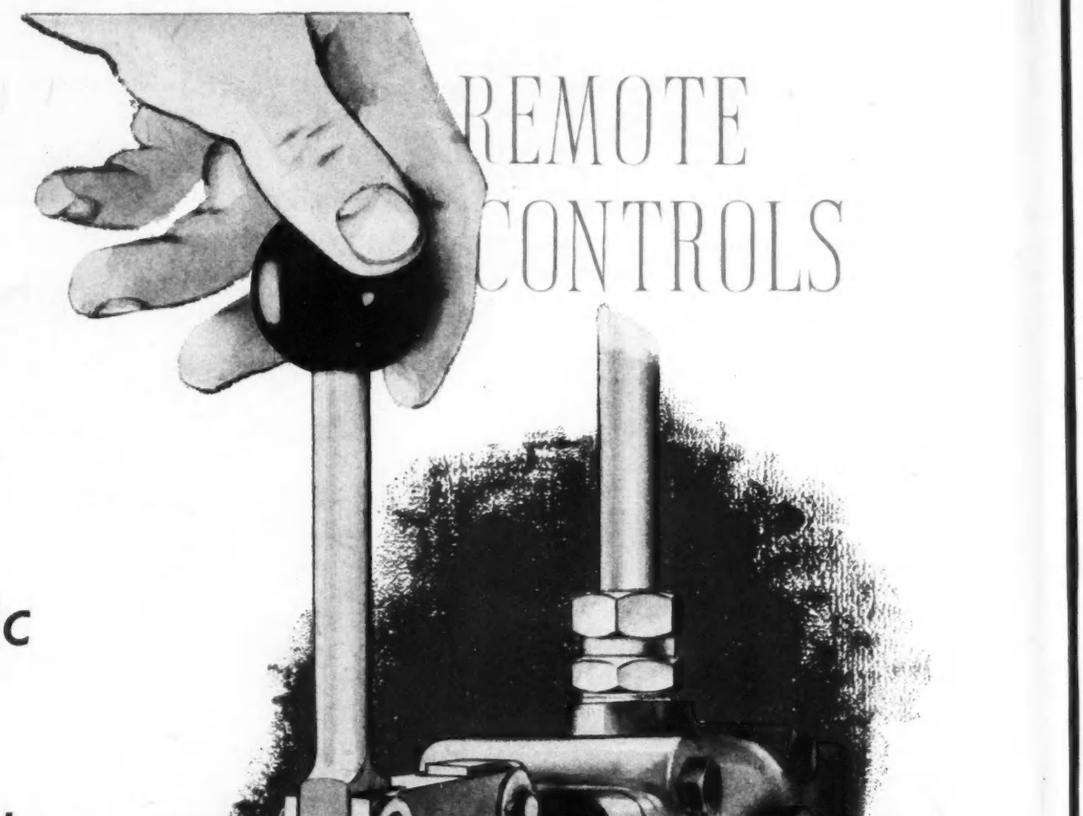
Vol. 179 No. 4657 LONDON, FRIDAY, APRIL 29, 1955 PRICE 2s.

UNIVERSITY OF MICHIGAN
ENGINEERING LIBRARY



GRINDING A BACK-UP ROLL

REMOTE CONTROLS



This hydraulic control can work for you...

Hydraulics with their numerous and often unique advantages are already employed for purposes of control and operation in practically every industry. It is particularly significant that Lockheed Industrial Hydraulics are to be seen in generating stations all over the world and are employed for an ever increasing number of purposes in the gas and other industries. Lockheed engineers are always at your service to discuss the application of hydraulics to your business.

Lockheed
REGD. TRADE MARK
INDUSTRIAL HYDRAULICS

AUTOMOTIVE PRODUCTS COMPANY LIMITED, LEAMINGTON SPA, ENGLAND

ENGINEERING

An Illustrated Weekly Journal

Vol. 179 No. 4657 APRIL 29, 1955

Leading Article
Einstein 517

Weekly Survey
More or Less Investment 518
German Titanium 518
French Railways 518
Shipbuilding and Shipping 518
Investment and the World Bank 518
Canadian Opportunities 519
Swiss Industries Fair 519
A Union's View of Automation 519
Awards for Ideas 519

Principal Articles
Einstein's Work 522
Canada: An Expanding Market: Opportunities and Difficulties for Britain 527
The Institute of Metals Spring Meeting. Control of Quality in Wrought Non-Ferrous Metals 529
Oil Film Extent in Complete Journal Bearings: Effects of Different Oil Entry Systems 530
Formation of a Hydraulic Jump: Significance of the Critical Depth 532
Cheaper and More Reliable Marine Machinery: Combination of Gas Turbine or Diesel Engine with Steam 533
180-MW Power Station at East Yelland: Generating Capacity in the South-West 534
Open-Web Bowstring Bridge of Prestressed Concrete 536
Loading, Transporting and Stacking with the Same Vehicle: Side-Operating Fork-Lift Truck 537
Distribution of Air for Ventilation 538
Twin-Jib Breakdown Vehicle 539
Thermometer and Limit Bridge: Direct-Reading Instrument 539
Drilling to Pre-Determined Depths 539
British Industries Fair: Engineering Exhibits at Castle Bromwich 540
Surface-Hardening Rendered Automatic: Development of Oxygen/Town-Gas Process 544
Two-Spool Propeller Turbine: 4,000-h.p. BE25 Maintains Power to 20,000 ft. 544
Cooling Hot-Air Fans: Checking Heat Flow 545
Engineer Equipment: Display at M.E.X.E. 545
Annual Report of the B.E.A.M.A. 547

Letters to the Editor
Examinations 520
Increasing the Life of Bandsaws 520
Gas Turbines and Heat Exchangers 520
Thick-Walled Cylinders under Internal Pressure 520

Obituary
Major F. B. Halford 524

Book Reviews
Mathematics in Action 525
Discontinuous Automatic Control 525
Engineering Analysis: An Introduction 525

Notes
Institution of Civil Engineers: Annual Dinner 520
Diesel Engine Users Association: Luncheon 520
Films and Human Relations: Conference 524
Hydraulics Conference 532
Open Days at R.R.L. and B.R.S. 535
Paint for Concrete Floors 539

Personal 521, Commercial 521, Books Received 526, Trade Publications 527, Launches and Trial Trips 538, Forthcoming Exhibitions and Conferences 546, Labour Notes 547, Notices of Meetings 548

* * *

Published every Friday by Engineering Limited 35 & 36 Bedford Street, Strand, London, W.C.2
TELEGRAPHIC ADDRESS *Engineering, Lesquare, London* TELEPHONE *Temple Bar* 3663

* * *

Subscription Rates for 12 months, Inland and Abroad £5 10s., Canada £5 5s. Subscriptions for periods of less than 12 months are based on the price of a single copy including postage [2*s.* 3*d.*]

EINSTEIN

MUCH has been written for popular consumption on Einstein, his life and work. The very abstruseness of his theories has been turned to good account in creating the legend of the mathematical genius. Those who have not been privileged to understand the Theory of Relativity—the majority, even, of educated people—have at least had their imaginations quickened by the illuminating power of his discoveries. Engineers—only one band removed from scientists in the spectrum of knowledge and its application—engineers are most of them virtually laymen with respect to Einstein's work. Yet perhaps the life of the great man, now ended, has a unique significance for engineers, quite apart from those aspects of their work which are now being derived more and more from his discoveries. What is that significance?

Engineering, it might be said, employs the minimum of theory for achieving the maximum of practical results. The engineering industry grew at first with hardly any foundation of science. Then when science came to buttress it and open up new vistas of opportunity—even then the engineer's natural reaction was, and is to-day, to rely on science as little as possible. It could hardly be otherwise, for engineers, during their education, must necessarily cut in at some intermediate level if they are to become useful members of their profession. Much that is fundamental in physics is taken on trust, so that there is still time left for applying "the great sources of power in Nature for the use and convenience of man." Thus the greatest discoveries of science filter slowly down to the realm of the engineer. At the universities, more than anywhere else, the filtering process is fostered, but a generation or more may be required to complete the process everywhere.

The work of engineers is interwoven with the practice of management, with trade and economics, with the study of human relations and many other subjects. The interplay of these parts of the industrial whole has its attractions, even fascination. It is the plane of action in society. It is also the plane on which compromise operates; where power and greed run amok; where the noble phrase "the use and convenience of man" is made a mockery; where the service of the servants of mankind is not accepted as a service but is grabbed—nay, ordered—and prostituted for ignoble ends. And there seems to be no escape: the enormous structure of applied science and engineering is pushed and pulled along by human agencies that have no connection with the disinterested power of intellect that built it. Small wonder, then, that an engineer turns wistfully to that realm of thought in which Einstein was supreme. Here, maybe, the mind can rove freely and ponder on the universal. As poetry is to everyday speech and writing, so pure science is to engineering.

Albert Einstein was 26 years of age when the "storm broke loose" in his mind. Born on March 14, 1879, he was working in the Swiss Patent Office when, in 1905, he wrote his first papers on Relativity. The story of his developing ideas has been told many times and need not be repeated here. Professor H. Levy, Emeritus Professor of the University of London and Head of the Department of Mathematics at Imperial College, has written, for this issue of ENGINEERING, a brief review of Relativity and its technical implications. Even after 50 years, Einstein's insight is still seen to be extraordinary. Engineers, as Professor Levy remarks, have continued "to split space-time into relatively indistinguishable spaces and times with nearly enough the same chronology of events in very nearly the same geographical locations." With the growth of specialisation which has taken place in those 50 years, we may now doubt whether it will ever again be possible for a man to arrive at such a fundamental conception. Einstein in 1905 was not a highly educated young man of science. He had not had the long and expensive education that many of his contemporaries, and many since, have had. But by some trick of Nature, which the post-mortem study of his brain is hardly likely to explain, the pattern of his knowledge and experience at that time, combined of course with an exceptional intellect, led to that surge of creative thought which set him on the most remarkable path of modern science.

Can that ever happen again? In some specialised field—probably; but in fundamentals—improbably. In later life Einstein became increasingly concerned with the practical and political consequences of his work. That characteristic humility which was part of his ability to see almost face to face where others see through a glass darkly—that humility made him sensitive to the deeper issues of humanity. He must often have striven for a formula, though not a mathematical formula, which would avert the mounting peril of his age. That he failed, as everyone else has failed, need not be accepted as evidence of the impossibility of ever finding a solution. There may be a young man in his twenties to-day who will be blessed with a blinding light of revelation. He may even be an engineer; for engineers stand in a special relationship to science and their fellow men.

Weekly Survey

Cover Picture. *In recent years four-high and "cluster" rolling mills of various types have been introduced in which the "working" rolls are of relatively small diameter. These are reinforced or strengthened, above and below, by heavy, large-diameter rolls termed "backing" or "back-up" rolls. The finish-grinding operation of such a backing roll, made of cast steel and weighing 45 tons, is shown in the cover picture.*

★ ★ ★

MORE OR LESS INVESTMENT

In a recent broadcast Mr. Colin Clark, the Director of the Institute of Agricultural Economics at Oxford, threw a bombshell among his fellow economists by suggesting that there was no longer a problem in maintaining an adequate level of industrial investment in this country. He supported this opinion with arguments, largely from American sources, which showed that in highly industrialised countries the ratios of the value of the national stock of capital for annual national output tends to fall. In other words, the cost of new capital in relation to the output it produces falls while the efficiency of its use rises.

While admitting the general proposition, Mr. Austen Albu, M.P., in a broadcast reply, doubted whether Mr. Clark's conclusions were the correct ones. He pointed out that the benefits to be obtained from the fuller utilisation of capital which had accompanied full employment had reached the limit and that our need to take advantage of the new scientific developments would involve a high level of capital expenditure. So would the special economic position of this country in relation to supplies of raw materials. The capital in our transport services, both railways and roads, was either obsolete or woefully inadequate; and much of our existing social capital such as schools, hospitals and muncipal buildings needed replacement.

In a third talk, Mr. Robin Morris, the young Cambridge economist, made a strong plea for a revolutionary change in attitude to shift working as one of the most certain ways of raising the standard of living from a given total of capital recourses. He suggested, however, that for this to take place our whole industrial life, transport time-tables, shops and entertainment hours, schools and pubs, would have to be geared to the change. This would mean a more intensive use, not only of factory equipment, but also of offices, electricity generating stations, for export services, shops, cinemas and theatres, and also of scarce managerial skill. Only this way could the present social drawbacks of shift working, due to its abnormality, be mitigated. He doubted however whether under present conditions, some shift working was profitable for many individual firms, except in the Lancashire cotton industry, subject as it is to intense foreign competition. He quoted the opinion of Col. W. A. Grierson, chairman of an important textile firm, that the cotton industry needs only half the present mills, but that they should run double day shifts, and his advice to shareholders in firms which had not introduced modern machinery to insist on voluntary liquidation while their companies still had substantial liquid assets, so that the efficient mills could take over their labour.

★ ★ ★

GERMAN TITANIUM

Friedrich Krupp have already begun the production of titanium and are exhibiting a 110-lb. forging at the Hanover trade fair which began last week. A challenging and optimistic statement by the company describes titanium as "the new metal of modern industry" and comments that "its appearance on the European industrial scene is as revolutionary and as important as that of aluminium and stainless steel years ago." This new evidence of the forces that are rebuilding the Krupp concern on the most modern lines will be a little disconcerting to those who expected at least some control of German war potential. The company are confident that they have overcome the production problems that have delayed its use on a commercial scale. They believe that there is no shortage of raw materials and state that their main source of supply will be the ilmenite mines of Norway.

Krupps say, somewhat surprisingly, that so far titanium has been used mainly for domestic purposes and in the production of modern trains. They stress, however, that its main value lies in its good heat-resistance properties and to its high tensile strength-weight ratio which makes it ideal in the manufacture of jet aircraft. I.C.I. thus have a major European competitor who may be ahead of them in the competitive race (see survey note, November 22, 1954) although the demand for good-quality titanium metal is likely to exceed the Western World's capacity to supply it for some years.

In view of the controversy that exists on the relative merits of the various processes in use for the production of the metal, it will be most interesting to know which process has been selected by Krupps, and on what scale is their current output. I.C.I.'s plant, which is scheduled to begin production next month, has a capacity of 1,500 tons a year, using the sodium process. As pointed out in the earlier survey note quoted above, some U.S. and Canadian companies are using an electrolytic process which, they say, is cheaper.

★ ★ ★

FRENCH RAILWAY COSTS

French Railways (S.N.C.F.) display in their annual report—*L'Année Ferroviaire*, 1955—an optimistic outlook on capital expenditure rarely encountered among enterprises with a large and growing deficit. In 1953 the trading deficit amounted to Frs. 122·3 milliards (approximately £122 million), about two-thirds of which was offset by various forms of State subsidies. The reasons for this deficit, which amounted to nearly 24 per cent. of total income (*recettes d'exploitation*) are given as "competition from other forms of transport not bound by considerations of public service." This fact is accepted as a political inevitability and French Railways see as their only way out of the red a large programme of capital expenditure to reduce operating costs. There is no suggestion of raising charges, which are said to be, in real terms, somewhat lower than in 1939 and some 48 per cent. lower than in 1929 (freight charges). The report estimates that fares would have to be raised by 80 per cent. to eliminate the deficit on passenger traffic, without any decrease in the present level of subsidies which are required "to maintain uneconomic services."

The three main ways of reducing operating costs that are envisaged in the report are electrification, the use of Diesel traction (particular railcar services) mainly on branch lines and non-electrified regions, and higher average speeds. The major electrification programme is in the North-East region, where over 2,700 kms. will be electrified at the cost of Frs. 160 milliards (equivalent of one year's total traffic receipts from the region) and will, it is estimated, yield economies of over Frs. 9 milliards a year. The economies on rolling stock are most striking, the 1,000-plus steam locomotives being replaced by 327 electric locomotives. The details of this plan were discussed in last week's issue, on page 499, where it was noted that some 40 per cent. of the total saving will accrue from economies in fuel. Examining earlier modernisation schemes, the report argues that the economies effected have paid back at the rate of 20 per cent. per annum, and suggests that the increases that are likely in the amount of freight and in the number of passengers carried—arising from industrial growth as well as from gains at the expense of road transport—should enable an even quicker amortisation of new plant.

The scope for the replacement of steam traction by Diesel or electric remains considerable; in 1954 over two-thirds of the total traffic was drawn by steam locomotives, and substantial economies are still looked for in increased efficiencies for steam traction.

Recent spectacular speed records set up by electric locomotives, designed to test the track and the locomotives, have been of great value in solving some problems related to higher average speeds. This, perhaps, more than any other factor, is expected to yield major economies and so enable French Railways to compete with road transport and eventually balance their books.

★ ★ ★

SHIPBUILDING AND SHIPPING

By the latter half of 1954 the revival in freight rates had so improved the outlook for shipping that there was a rush to place orders for new tonnage. The ships were wanted in a hurry, and it was therefore not surprising that a high proportion of the orders went to foreign shipbuilders who could promise speedy delivery. British shipbuilders, for the most part still with two years' work on hand, could not expect a larger share of orders until unused capacity abroad filled up. The fact that Lloyd's Register Shipbuilding Returns for March show that the British proportion of world tonnage has declined a little since last December is thus no ground for pessimism. At the end of March, 5·96 million tons of shipping were under construction in the world, about 2 per cent. more than in December; the British tonnage, on the other hand, remained constant at 2·14 million. It is significant that the tonnage under construction in some of the countries which received the largest orders actually fell: the German tonnage (665,000 in March) was 14 per cent. less than in December, and the French 8 per cent. less. It seems, therefore, that it has not been possible to begin work on the new orders quickly enough to prevent berths from falling empty. Some countries, of course, notably Japan and Italy, have increased their tonnage under construction substantially.

The present trend shows the strength rather than the weakness of British shipbuilding. On the other hand, there is no room for complacency. Continental yards, who apart from subsidies, have sometimes the important advantage of shift-working, have been able to quote firm and very competitive prices. A continuing high level of freight rates is, moreover, by no means assured although the prospects are bright enough at present. The prosperity of British shipowners in particular is already somewhat restricted by such factors as the slow turn-round of ships in port, and increasing flag discrimination. Mr. A. I. Anderson, President of the Chamber of Shipping of the United Kingdom in a recent statement, pointed out that no form of discrimination is more harmful to the encouragement of world trade by cheap and freely competitive sea transport than the reservation of "national cargoes for national ships." Unhappily, the example of big countries is being avidly copied by smaller States, and although the subject will be discussed by the International Chamber of Shipping whose Congress will be held in Tokyo next month, it will be extremely difficult to get the offending States to repeal their discriminating legislation.

★ ★ ★

INVESTMENT AND THE WORLD BANK

An attempt is to be made to develop the investment activities of the World Bank by creating a new institution to be called the International Finance Corporation. A charter for the new organisation has now been circulated to the 56 member-governments of the World Bank inviting them to subscribe to its articles of agreement and also to its capital. The basic object of the

I.F.C. will be to encourage the growth of productive private enterprise in member countries, especially in less-developed areas. In contrast to the World Bank, the I.F.C. will be authorised to invest in productive undertakings along with private investors without a government guarantee. Membership in the Corporation will be open to member-governments of the World Bank. It will have an authorised capital of 100 million dols. available for subscription by members proportionate to their subscription to the capital of the World Bank. It is proposed that the new organisation should come into being when a minimum of 30 governments have subscribed at least 75 million dols. of capital. Affiliation to the World Bank will be secured by each governor of the bank who represents a government which has joined the corporation becoming a member of the board of Governors of the new organisation.

The I.F.C. will no doubt carry on the good but unobtrusive work which the World Bank has undertaken of recent years in collaborating with Governments and private concerns in various territories in developing local resources. The activities of the World Bank have developed a useful and proven technique of international investment under conditions where resources of power, raw materials, man-power and technical skill (or some combination of these) have been lacking or difficult to mobilise. Just as the earlier efforts of the World Bank to nurture international confidence in world-wide investment was over-shadowed by the glamour and sheer size of the Marshall Plan, so to-day the new organisation is being born to the accompaniment of massive investment planned by the United States in Asia. President Eisenhower asked the U.S. Congress last week to approve a programme in the 1956 fiscal year for about 1,500 million dols. for economic aid to Asia, in addition to 1,000 million dols. for projects which will stimulate both defence and civil economic activity. A programme of this size rather dwarfs the proposed capital resources of the I.F.C. but it has to be borne in mind that such large short-term investment programmes, with their pronounced political flavour, can help the smaller but long-term project provided they are phased properly. These huge investment programmes are vital to the security of the West, but, when it comes to building up long-term international confidence in foreign investment, the I.F.C. could have a critical part to play. This is the kind of unspectacular tortoise which could win in the end.

★ ★ ★

CANADIAN OPPORTUNITIES

Canada is a rapidly expanding market. As an article on page 527 points out, it is already the fourth largest trading nation of the world By 1980 its national income—which to a very large extent derives from international trade—should have increased threefold. Unfortunately, this expansion does not mean an automatic increase in British exports to Canada, which have increased much less in the past few years than those of other countries. United States manufacturers have the advantage of close proximity; their home market closely resembles the Canadian in character; and they have devoted so much capital and effort to building up comprehensive sales and service organisations that it is extremely difficult for new British entrants to secure a footing in the market.

Nevertheless, the Canadians are as anxious to buy more from the United Kingdom as British exporters are to sell more to them. They are already faced with a deficit in their trade balance with the United States, and it will not be easy to rectify this by increasing their exports to the United States. These are rather too closely akin to the United States domestic produce. But for the dollar shortage, on the other hand, the United Kingdom could be an excellent market for Canadian exports of primary products; before the war the United Kingdom took the bulk of Canadian exports, it now takes only 17 per cent.—and the United States 60 per cent. Canadians have been very active in exploring the possibility of buying more from the United Kingdom; many companies and public utilities, both independently and through their trade associations, have carried out surveys and sent buying missions. British manufacturers, too, have devoted much energy to studying Canadian market conditions. It is perhaps true that the greater ease of selling in other markets where the non-convertibility of sterling has given some protection to British goods has prevented the British sales drive in Canada from being as vigorous as it might have been.

British manufacturers, of course, cannot always afford the large capital outlays necessary to establish sales and service organisations which will enable them to compete really effectively where these are important with American manufacturers. This means that although the heavy investment programme in the exploitation of Canada's natural resources is creating a heavy demand for capital equipment, British goods may find it difficult to make headway in many cases. Now that the British contractors are actively engaged in Canada, however, it may be possible to make a useful opening for British contractors' plant. Canadian investment in manufacturing industry is also rising rapidly, and this should mean better markets for many types of British machinery. British specialities like sports cars and bicycles should also continue to find a good market.

★ ★ ★

THE SWISS INDUSTRIES FAIR

The 39th annual Swiss Industries Fair, which closed at Basle on April 26, followed previous practice in being equally representative of all branches of Swiss industry, as the British Industries Fair is intended to be of British industry; but whereas the B.I.F. omits considerable sections of the British engineering industry which have their own periodical exhibitions, the Swiss Fair offers a very wide review of the engineering products of the country.

Naturally, one of the most impressive sections was that devoted to watches and clocks—especially watches—and there is no doubt that the interest that this has for visitors of all ages and occupations is much enhanced by the opportunity to see, in an adjacent hall, the beautifully precise machines used to produce the numerous components, and the measuring instruments, many of them automatic or semi-automatic in action, employed to maintain the fine tolerances on which the prosperity of this particular industry depends. This part of the display was by no means confined to this type of machinery. Though most of the tools shown were repetition machines of one sort or another, there were few which approached the category of "heavy engineering"—probably by reason of limitations of space. It was stated that the demand for stands had necessitated a severe restriction of their dimensions, especially in Hall 6, where the machine tools were displayed, even though woodworking machines, electrical plant, machines for the laundry and foodstuffs trades, and various other classes were relegated to other halls. Transport also, which constituted an important section, had a hall to itself.

The self-evident fact is, however, that the Fair has become such a popular event, both with exhibitors and public, that it has outgrown the available accommodation, even though this has been considerably extended. Last year it was visited by 680,000 persons, of whom some 25,000 came from other countries, and it is likely that this figure will have been at least equalled this year. In such circumstances, there is a choice of two possible courses, either to enlarge the accommodation or to divide the coverage. The latter course is being adopted and—wisely, in our view—not by holding two or more Fairs in one year, which probably would be inconvenient to many of the visitors from other countries, but by arranging that certain industries exhibit in alternate years or possibly at longer intervals. This is in line with a tendency already observed elsewhere, including Britain, and is likely to become more generally adopted. Particularly is this so as many trade associations are finding it necessary to restrict the number of such exhibitions in which their member firms may take part, not only to limit the considerable expenditure involved, but also to ensure that the displays which they do organise shall be truly representative. It may be taken as certain, however, that whatever steps are taken in this direction, the Swiss Industries Fair will continue to be regarded as one of the major events of its kind, not only in Europe, but in the world.

★ ★ ★

A UNION'S VIEWS ON AUTOMATION

The increasing pace at which automation is developing, and the rate at which it appears to be likely to develop in the future, must inevitably create important human and social problems. These difficulties will require expert and sympathetic handling if they are to be successfully overcome. This aspect of the subject is being carefully watched by the trade unions in this country and some reflections on their attitude are contained in the April issue of *Man and Metal*, the official journal of the Iron and Steel Trades Confederation.

The journal considers that the trend towards "push-button" control, though widespread, is at present more apparent in the United States than elsewhere. As an example of automation, the case of an electronic computer installed by an insurance company is quoted. It performs, without assistance, the work of a hundred punch-card machines served by 135 human operators. At the new works of the Ford Motor Company at Cleveland, a series of electronically-operated machines, serviced by 250 skilled men, are reported to be turning out twice the amount of work previously done by 2,500 employees. In the American oil-refining industry, automation has dispensed with the services of 10,000 employees in less than six years although production has increased by 22 per cent.

American unions, it is said, although much concerned about automation, are not opposed to it, but would like to have a governmental inquiry into its potential impact on American economic, social and political life. In this country, the General Council of the Trades Union Congress are keeping a close watch on the system and the proposal of the Department of Scientific and Industrial Research to undertake an investigation is especially welcomed. So far as the British iron and steel industry is concerned, there has been "no little progress" in automation and this the unions have encouraged, in the belief that a higher standard of living is inseparable from technical progress. The journal's general conclusion is that, so far as is known, automation has caused little, if any, redundancy, although some employees have had to change their jobs.

★ ★ ★

AWARDS FOR IDEAS

It is an excellent plan to award cash prizes for suggested designs of new machines, and to offer these prizes to people outside the firm. That is what is being done by Arpic Engineering Limited, of Queenslie Estate, Glasgow. They are offering two awards of £250 for "the best entries outlining a piece of plant or machinery which will either meet an unfilled need in the contracting or mining fields, or which will be an improvement in the present method." They will make a further award of £1,000 if they decide to develop and produce the selected project, as well as additional awards according to merit. Schemes of this kind can help to close the gap between user and maker, with benefit to them both.

THE INSTITUTION OF CIVIL ENGINEERS

Annual Dinner

The annual dinner of the Institution of Civil Engineers was held at the Dorchester Hotel, London, on Thursday, April 21, last. Mr. David M. Watson, the President, was in the chair. The principal guests included the Rt. Hon. Viscount Waverley, P.C., chairman of the Port of London Authority, His Excellency Dr. D. U. Stikker, the Netherlands Ambassador, the Rt. Hon. Alan Lennox-Boyd, M.P., Secretary of State for the Colonies, and the Very Reverent A. C. Don, the Dean of Westminster.

In proposing the toast of the Institution, Lord Waverley referred to the Charter of the Institution wherein engineering is defined as " The art of directing the great sources of power in nature for the use and convenience of man . . . " Nowadays that required the closest collaboration between the scientist and the engineer, and Lord Waverley welcomed the decision of the three senior Institutions to associate themselves with the work and aspirations of the Parliamentary and Scientific Committee, of which he was President.

Later in the evening, when responding for the Guests, Mr. Alan Lennox-Boyd referred to the importance of engineering works in the colonies and other overseas territories. There were 77 million people who were the direct responsibility of the United Kingdom and who had an equal right to protection and help as those who lived in the countries of the United Kingdom itself. Their and our future were deeply involved in the success of colonial development, and it was no exaggeration to say that the whole programme of colonial development might fail completely because of the shortage of skilled men. So while there were all sorts of tempting opportunities at home and everything that was needed to keep the young man in touch with the daily developments in scientific and technical fields, the Minister appealed for members to remember that our forefathers were prepared to take some risks and to go overseas at a time when there were equally rich opportunities awaiting them here at home.

* * *

DIESEL ENGINE USERS ASSOCIATION LUNCHEON

Value of Co-operative Research

In speaking at a luncheon given by the Diesel Engine Users Association on Thursday, April 21, Rear Admiral (E) D. J. Hoare, C.B., M.I.Mech.E., emphasised the value of co-operative research, and in particular its importance to the users of Diesel engines. The luncheon was held at the Connaught Rooms, London, and the chairman on this occasion was the Association's President, Mr. F. J. Mayor, M.I.Mar.E., A.M.I.Mech.E., who, in proposing the toast, " Our Guests," observed that the D.E.U.A. was now in its 42nd year.

The toast, " The Association," was proposed by Admiral Hoare, who is Director of Research of the British Internal Combustion Engine Research Association. He spoke of the advantages yielded by centralised co-operative research as distinct from research within a factory, and drew special attention to the benefits gained by concentrating information and research equipment in one place. Moreover, in a factory the research worker was too accessible so that his efforts were frequently diverted to other tasks, whereas at a central laboratory he would receive the help and encouragement of people engaged in work similar to his own.

Admiral Hoare also declared that research on advanced types of Diesel engine was necessary if this prime mover was not to be overtaken by the gas turbine, and if we were to remain abreast of foreign competition in this field. Research associations were a British idea but they were catching on abroad and it was important that we continued to make the best use of them. Finally, he said that the challenge offered by the gas turbine was just what the Diesel engine needed to keep ahead of the gas turbine.

The luncheon concluded with a vote of thanks to the President, proposed by Mr. A. K. Bruce, M.I.Mech.E., past-President.

* * *

Letters to the Editor

EXAMINATIONS

SIR, In the leading article in your issue of April 1 you have posed the examiner's problem as being whether he should ask of the candidate: " What do you know ? " or " What don't you know ? "

May I offer a third option which seems to go a little nearer to the root of the matter : " What is your ability to derive pertinent conclusions from superficial data ? "

Yours faithfully,
E. H. BATEMAN.

Sevenoaks,
April 21, 1955.

* * *

INCREASING THE LIFE OF BANDSAWS

SIR, Some confusion may be caused by the article you published on the use of Stellite for increasing the life of bandsaws (April 8, page 443).

The first point is that Stellite is not a hard metal as this title is recognised in this country and many abroad as applying to tungsten carbide. This might not seem very serious, but when you consider that special wheels must be used for tungsten carbide whereas ordinary ones are perfectly satisfactory for Stellite, then you will appreciate that much of the value of the application would be lost if indeed tungsten carbide was the medium used. The second point is that you have referred to Montague L. Meyer, Limited, as being from Manchester, whereas their plant and timber organisation is in London.

The problem of multiplying the life of bandsaws has been present for many years now and we feel that we have been able to offer a simple solution.

Yours faithfully,
R. BRAITHWAITE,
Sales Manager.

Deloro Stellite, Limited,
Highlands-road,
Shirley,
Birmingham.
April 7, 1955

* * *

GAS TURBINES AND HEAT EXCHANGERS

SIR, Mr. Toogood's letter in your issue of April 15 regarding my comments on the subject of heat exchangers for gas turbines is most interesting. His remarks do much to clarify the problems involved in designing and producing " really good " heat exchangers.

It is true that a variety of heat exchangers for gas turbines has been made and that there have so far been few repeat orders to make the manufacturers' task easier. Failures to achieve the designed performance (within a reasonable margin) have been relatively few, though a fair proportion of heat exchangers have encountered mechanical difficulties in operation. My point was that the fact that the heat exchanger has a most important part to play in the future of the gas turbine was not emphasised anywhere in the book, along with the undoubted fact that there is the possibility of considerable improvement over existing types. These are in many cases excellent within their limitations, but very few attempt to obtain thermal ratios higher than about 75 per cent. If this could be increased to 85 or 90 per cent. without excessively high losses, cost or weight, the effect on the overall performance of gas-turbine plant would be very important.

While the achievement of such a performance may be difficult and fraught with such practical problems as cleaning, it is by no means fundamentally impossible. It must be remembered that not very long ago the attainment of the compressor and turbine efficiencies reached by the best present-day designs was regarded as being extremely unlikely by most people. The amount of research and development work which has been put into heat exchangers is very small compared with that lavished on the other components of the gas turbine (Mr. Toogood's company being one of those which has done most in this field). I believe that much better heat exchangers than have been used in practical service so far are both necessary and possible, and I have no doubt that they will be produced.

Mr. Toogood points out that the road-vehicle application is a specially difficult case. As I said in the review, " heat exchangers are one of the most vital needs of the gas turbine and one on which its future must greatly depend." This is particularly true of the vehicle engine, and I think that it would be unwise to prophecy that the gas turbine will in the long run fail to find its place in transport use because it proves to be impossible to solve the heat-exchange problem, even though the difficulties now appear formidable.

As Mr. Cheshire says in his letter in your issue of April 22, the expression which he gave for the pressure gradient in the impeller channels is the condition for radial equilibrium in a flow with zero, or constant, radial velocity. My point was that as stated, without qualification, this was not correct. Although the radial velocity is often fairly constant in the outer parts of the impeller, the most important region as regards the losses which are likely to be incurred is between the inlet and the final radial section. Here this assumption is not justified as there is necessarily a considerable radial acceleration.

The question at issue was not one of great seriousness in itself and perhaps received undue emphasis in the review. However, it is an example where an unqualified statement is made which cannot be accepted as being generally applicable.

Yours faithfully,
" YOUR REVIEWER."

[*Editor's note*: Mr. Toogood wishes to correct the statement in his letter that the pin-fin exchanger was built by the Air Preheater Corporation for the Allis Chalmers Manufacturing Company: it was built for Clark Brothers Company.]

* * *

THICK-WALLED CYLINDERS UNDER INTERNAL PRESSURE

SIR, In ENGINEERING of March 11 (page 293), Dr. Crossland and Mr. Bones replied to my formula for the ultimate strength of thick-walled cylinders: " The approximate agreement between the equation and the experimental results," they say, " is entirely fortuitous."

May I draw their attention to the article in *Zeitschrift des Vereines deutscher Ingenieure*, vol. 97, No. 6, February 21, 1955, " Berechnung der Wanddicke von innendruckbeanspruchten Stahlrohren." For the case treated in the article in ENGINEERING they give on page 161:

$$\frac{p}{100\,\sigma_s} = ln\frac{d_a}{d_i} = lnu, \quad . \quad (4)$$

(curve E in Figs. 3 and 4). This is indeed my formula (4).

One should not ignore the German formula for pipes according to the D.I.N.2413 as they give the well proved figures for calculating modern steam-pipes for high temperatures and pressures.

Yours faithfully,
F. VAN ITERSON.

Waalsdorperweg 108,
The Hague.
March 28, 1955.

TRAINING AGRICULTURAL ENGINEERS

At the annual luncheon of the Institution of British Agricultural Engineers, held on April 22, the toast of the Institution was proposed by the Minister of Agriculture and Fisheries, the Rt. Hon. D. Heathcoat Amory, M.P. He said that Britain carried more tractors to the acre than any other country in the world, and increase in mechanisation had enabled farmers to increase production even with a smaller labour force. The agricultural machinery industry (which was considered in "The Engineering Outlook—3," in the issue of ENGINEERING for February 28, 1955, page 107) had been able to export £52 million of its total production of £92 million. There was a need for trained men to expand the markets at home and abroad, but even though the demand was great, educational standards of agricultural engineers had to be kept up. The task of the Institution should be to encourage more to obtain the necessary qualifications.

In reply, Mr. D. P. Ransome, M.I.Mech.E., M.I.Prod.E., President of the Institution, said that the membership of the Institution was rising but that standards were being maintained and, if anything, stiffened. Evidence of the reputation of the National Diploma in Agricultural Engineering, which was originated by the Institution, had come in its most striking form from the Commonwealth. New Zealand had asked that certain courses should be considered suitable to prepare candidates for the N.D.Agr.E.; after examining the courses the I.B.A.E. had approved them, although they stipulated that the papers should be marked in this country. The N.D.Agr.E. was the examination for professional agricultural engineers.

Mr. Ransome said that members of the Institution were in great demand, particularly overseas. It was important that our experts should go overseas, because they would undoubtedly encourage the use of British equipment wherever they went. There was also a need for a central college of agricultural engineering for students from home and overseas. At present students tended to go to colleges in Germany and the United States, with consequent benefit to the farm machinery industries in those countries. In conclusion, Mr. Ransome said that the Council had awarded honorary membership of the Institution to Mr. Harry Ferguson, in recognition of his outstanding services to agricultural engineering.

* * *

STRUCTURAL BEHAVIOUR

Correlation of Theory and Experience

A conference on the "Correlation Between Calculated and Observed Stresses and Displacements in Structures" is to be held at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on Wednesday and Thursday, September 21 and 22, 1955, at which twenty papers will be presented and discussed in four separate sessions. After the official opening of the conference by the President of the Institution, Mr. David M. Watson, on the Wednesday, the rest of that morning will be devoted to discussions on papers in the first session, Group I, "Philosophy and Techniques of Testing"; this will be followed after a luncheon break by the second session, Group II, "Steel Structures." Discussions on papers in the third and fourth sessions, embracing Group III, "Concrete Structures," and Group IV, "Earth Pressures and Movements," respectively, will be held on Thursday, September 22.

The papers to be presented at the conference will be printed in a preliminary volume available in August, and a final volume containing the discussions will be printed towards the end of this year. A registration fee of £2 will entitle participants to a copy of the preliminary and final volumes of the proceedings, buffet lunches, and teas. Extra copies of the proceedings will be obtainable, price £1 10s. per set. Application forms (and also any further information required) are obtainable from the secretary, the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, and these should be returned not later than August 1, 1955.

* * *

PERSONAL

The following have been elected by the Governing Body to Honorary Fellowship of the Imperial College of Science and Technology, London, S.W.7: DR. ERIC ASHBY, A.R.C.Sc., D.I.C., President and Vice-Chancellor, Queen's University, Belfast; MR. L. C. HILL, D.S.O., M.C., A.R.S.M., D.I.C., M.Inst.M.M., technical adviser to the board of the Rio Tinto Co.; SIR GEORGE H. NELSON, F.C.G.I., M.I.Mech.E., M.I.E.E., chairman and managing director, the English Electric Co. Ltd., and member, Governing Body, Imperial College; Emeritus PROFESSOR J. A. S. RITSON, D.S.O., O.B.E., M.C., M.I.Min.E., M.Inst.M.M., Hon.A.R.S.M., formerly Professor of Mining at Imperial College; and Emeritus PROFESSOR SIR GEORGE P. THOMSON, M.A., Hon. A.R.C.Sc., F.R.S., Master of Corpus Christi College, Cambridge, and formerly Professor of Physics at Imperial College.

VISCOUNT BRACKEN, P.C., the HON. ALEXANDER HOOD, SIR ERIC SPEED, K.C.B., K.B.E., M.C., and GENERAL SIR WILLIAM MORGAN, G.C.B., D.S.O., M.C., have been elected directors of Associated Electrical Industries Ltd.

SIR GRAHAM HAYMAN has been elected President of the Federation of British Industries, 21, Tothill-street, London, S.W.1, in succession to SIR HARRY PILKINGTON, who has held office for two years.

MR. P. L. JONES, M.C., B.Sc., M.I.C.E., M.I.Mech.E., Wh.Ex., M.I.Mar.E., director, Swan, Hunter, and Wigham Richardson Ltd., and the Wallsend Slipway and Engineering Co. Ltd., has been re-elected President of the North East Coast Institution and Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne, 1.

MR. GEORGE HALLEWELL, M.I.Mech.E., for the past 20 years chief engineer to Blackstone & Co. Ltd., Stamford, Lincolnshire, has been elected a director of the company.

MR. H. J. ARMSTRONG, manager of the Coventry Works of the British Thomson-Houston Co., Ltd., Rugby, has retired, and MR. E. G. CROSSLING, who has been assistant manager since July, 1945, has been appointed to succeed him as manager, with effect from April 20.

MR. ROGER GRESHAM COOKE, C.B.E., M.P., has been elected to the board of directors of Kerry's (Great Britain) Ltd., Warton-road, Stratford, London, E.15.

MR. H. G. DAVIS, B.Sc., formerly assistant technical manager, Acheson Colloids Ltd., 18 Pall Mall, London, S.W.1, has been transferred to the Plymouth Works of the firm as deputy works manager. MR. J. B. MACLEAN, B.A., has joined the export section of the sales department of the company, and MR. G. C. B. ANDREW has been appointed publicity officer.

CAPTAIN R. C. PETTER has relinquished his appointment as managing director of Petters Ltd., Staines, but remains a non-executive member of the board of that company and also of the board of the Brush Group Ltd., the parent company, positions he has held for many years. MR. D. K. FRASER has now been appointed director and general manager of Petters Ltd., Staines.

Following on the death of MR. JOHN F. FARQUHARSON, the practice of John F. Farquharson & Partners, chartered structural engineers, which he established, will be carried on, as he had arranged, by his son, MR. DOUGLAS G. FARQUHARSON, B.Sc. (Eng.), A.C.G.I., A.M.I.C.E., M.I.Struct.E., and MR. LESLIE G. JONES, A.M.I.Struct.E. The style of the firm and the address, 34, Queen Anne-street, London, W.1, (Telephone: LANgham 6081/2), will remain unchanged.

MR. C. F. BOLTON, M.B.E., A.M.I.E.E., who retired recently from the Central Electricity Authority after having been transmission engineer for the South-Eastern Division, has become consulting engineer to the English Salvi Co. Ltd., 11, Kensington Church-street, London, W.8.

MR. S. P. PRITCHARD, A.M.I.E.E., has been appointed, as from May 1, resident partner in Bombay to Associated Consulting Engineers (India), of which Kennedy and Donkin, 12, Caxton-street, London, S.W.1, are the principals. Mr. Pritchard is aking the place of MR. A. C. FIELDING, B.A., M.I.C.E., M.I.E. (India), who has returned to London to act as consultant to Associated Consulting Engineers (India) in London.

MR. D. L. HUSSEY has resigned from the board of directors of Iraanse Aardolie Raffinage Maatschappij (Iranian Oil Refinery Co.) N.V., and MR. P. E. KUHL has been appointed to fill the vacancy thus created.

MR. T. C. PATON has retired from the position of manager of the Glasgow office of Brookhirst Switchgear Ltd., one of the Metal Industries Group of Companies, but will continue to represent another member of the Group, Cantie Switches Ltd., in Scotland. MR. K. B. ALLAN has been appointed Glasgow-office manager for Brookhirst Switchgear Ltd., as from April 1.

DR. THEOS J. THOMPSON has been appointed associate professor of nuclear engineering in the department of chemical engineering at the Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A.

MR. A. R. COLLIE, formerly assistant sub-contracts officer, Westland Aircraft Ltd., Yeovil, Somerset, has been appointed sub-contracts officer, in succession to MR. J. WOOD, who has left the service of the company.

* * *

COMMERCIAL

THE HOYT METAL COMPANY OF GREAT BRITAIN LTD., Deodar-road, Putney, London, S.W.15, inform us that the construction and equipment of their new factory near Sydney, Australia, is completed and that it is now in full production. The title of their subsidiary company has recently been changed and it is now known as the HOYT METAL COMPANY OF AUSTRALIA PTY. LTD., 68-80 Hughes-avenue, Ermington, New South Wales. (Telegrams: Hoytaloy Sydney).

ARTHUR TREVOR WILLIAMS (PTY.), LTD., 16, Burlington House, Rissik-street, Johannesburg, South Africa, have been appointed sole selling agents for BROOKHIRST SWITCHGEAR LTD., for South Africa, the Central African Federation and Portuguese East Africa.

The first section of a new factory of HAMWORTHY ENGINEERING LTD., at Fleets Corner, Poole, Dorset, will be opened to-morrow afternoon, Saturday, April 30. The company's oil-burning and hydraulics division will be housed in the new factory, while the pump and compressor division will operate from the original quayside factory at Hamworthy.

INSPECTION EQUIPMENT, 19, Broad-court, Drury-lane, London, W.C.2, have obtained the sole agency for FEDREX portable industrial X-ray units, manufactured by the CARL DRENCK ELECTRO-TECHNICAL LABORATORIES, Copenhagen, Denmark.

ALMIN LTD. inform us that their new address is Almin House, Stoke Poges, Buckinghamshire. (Telephone: Slough 25061/4.)

The board of ASSOCIATED ELECTRICAL INDUSTRIES LTD. announce that their subsidiary company, THE EDISON SWAN ELECTRIC CO. LTD., has absorbed two other subsidiary companies, BRITISH MECHANICAL PRODUCTIONS LTD., and the GENERAL ACCESSORIES CO. LTD. The principal activities of these two companies are the production of wiring accessories and radio components.

* * *

ROAD RESEARCH LABORATORY

New Site Chosen at Crowthorne

The Road Research Laboratory, where "open days" are to be held as announced elsewhere in this issue, is to move from its existing premises at Harmondsworth and Langley to a new site at Crowthorne, Berkshire. It is intended to complete first a testing track and a paved central area for traffic experiments and later to proceed with the laboratory buildings. This is noted in the report of Road Research Board for last year, given in *Road Research* 1954, published for D.S.I.R. by H.M. Stationery Office (4*s*.), and, say the Board, "We regard the transfer of the Laboratory to the new site to be of great urgency: we strongly recommend that the erection of the buildings should be started and pressed to completion as quickly as possible in the interests of efficiency." Completion of the transfer will mean that the two principal divisions, the Materials and Construction Division and the Traffic Division, as well as their supporting departments, will be brought together in a single establishment.

EINSTEIN'S WORK

By Professor H. Levy, D.SC., M.A., F.R.S.E.

ALBERT EINSTEIN lived during a period of great social stress, but in spite of its deeply disturbing impact he, more than any other man, was responsible for a transformation in human thought so revolutionary that many scientists and engineers are still unable to comprehend its full import. The difficulty arises in the first instance from the specialist nature of scientific language, the concepts and images it evokes, and its steady growth in the wake of specialised discovery. While in the past the gap has been partially bridged by the populariser, a new phase is now with us. Every branch of science tends now to lean more heavily on mathematics for the necessary logical precision, and the word "explanation" is changing its meaning. The engineer takes in his stride the formula $2\pi\sqrt{(l/g)}$ for the period of oscillation of a pendulum. The layman, who gazes at it blankly, would require a text-book on the concept of number, on algebra, geometry, mensuration and dynamics. On the other hand a tensor formula for the relation of gravitation to the curvature of a space-time continuum leaves the engineer at a loss, while the mathematician nods understandingly. Yet it has been the creation of new symbolisms, pregnant with concentrated meaning, that has made possible studies in fields that a more immature mode of description could never have penetrated.

Once this trend has been grasped much of the mystique fades from the genius of Einstein, and he is seen for what he was—one of the most direct and penetrating minds of his age, who, recognising the fundamental problems that called for solution, solved them because he was at home with this modern powerful symbolism. Because these problems lay at the roots of scientific theory, the consequences were of major significance to science, and therefore ultimately also to technology. Let us glance at some of these questions.

RELATIVITY

Roemer, a Danish astronomer, put forward in 1675 what was then a most imaginative explanation why the successive intervals between the eclipses of the moons of Jupiter increased and diminished as the distance between the Earth and Jupiter lengthened and decreased. Instead of light appearing simultaneously everywhere, he said, it had a *speed*; and from the varying intervals between the eclipses he calculated its value. Later Fizeau and Foucault experimentally verified this result. Towards the turn of this century Michelson, Morley, and Miller, American scientists, conceived the brilliant idea of measuring the speed of the Earth in its orbit, from the *relative* speed of light as the Earth moved towards the source in the sky, and six months later as it moved away. It was simple, and it deserved success. What was their amazement to find that the relative speed was the same as the ordinary speed—an incredible situation. Relativity of position and speed was of course a commonplace, bound up with our whole idea of a distinct unique space in which objects were located, and a unique distinct time which told us when these objects were in these locations.

At this stage the young Einstein, a junior assistant in the Swiss Patent Office, who had scraped through his examinations with great difficulty, dared to bend his mind to this problem. To accept the experimental statement that the measured speed of light was unchanged by the motion of the observer was either to give the lie to the whole of Newtonian Dynamics that engineers and scientists use at every turn; or alternatively to deny that science can be consistently constructed. The gauntlet had been thrown down to science, and this mild and modest young man had casually picked it up. Why do we assume, he asked in effect, that space and time are unique and separate entities? Once the question was asked, the approach became clear. Since it is by means of light that events are seen, begin with the assumption that for any two observers looking at the same process, but moving relatively to each other, the speed of light is the same, and see what this implies for space and time. This assumption knocked a linchpin out of the older structure, and the results were devastating. There emerged a unique space-time framework, such that each observer splits his own space framework, and his own time scheme, from the totality.

To engineers designing their bridges on the surface of a relatively small piece of earth, it was so far a matter rather of philosophic interest. Newton was still good enough for them, and any Einsteinian corrections, if they existed, were trivial. They continued to split space-time into relatively indistinguishable spaces and times with nearly enough the same chronology of events in very nearly the same geographical locations.

Einstein moved on from this examination of kinematics to dynamics. A particle whose mass we usually called m, moving with a velocity relative to us of V, now had, he found, a momentum of $mV/\sqrt{(1 - V^2/c^2)}$, where c is the speed of light. Stated in another way, this meant that if a body has a mass m when at relative rest, its mass when moving with relative speed V is $m/\sqrt{(1 - V^2/c^2)}$. Thus it seemed that mass was not constant, but depended on its speed, and when the latter approached that of light it became indefinitely great. This was indeed something new, although already suspected from the behaviour of high-speed electrical particles. By a simple use of the Binomial Theorem a good approximation to this expression is easily found to be $m(1 + V^2/2c^2)$.

Step by step, by this simple approach, Einstein transformed our preconceived notions about dynamical action. For example, suppose two masses m and M moving with speeds U and V impinge on each other, and rebound with speeds u and v. If we apply the usual Law of Conservation of Mass we must have—

$$M(1 + U^2/2c^2) + m(1 + V^2/2c^2) = M(1 + u^2/2c^2) + m(1 + v^2/2c^2),$$

and this at once leads to:

$$\tfrac{1}{2}MU^2 + \tfrac{1}{2}mV^2 = \tfrac{1}{2}Mu^2 + \tfrac{1}{2}mv^2.$$

But this is simply a statement of the Law of Conservation of Energy in the Newtonian sense; and it is derived from a statement of the Law of Conservation of Relative Mass! Two different Newtonian Laws have suddenly telescoped into one. This is not merely an economy of thought, but implies something very fundamental—that mass and energy in the conventional sense are two aspects of the same thing. In fact if, following Einstein, we write energy as $E = Mc^2/\sqrt{(1 - V^2/c^2)}$, we see that again by using the Binomial Theorem this is approximately $Mc^2 + \frac{1}{2}MV^2$, and since energy is always relative to the system that can tap it, the intrinsic energy is Mc^2. Notice how, as a mere by-product, the fundamental formula for the calculation of atomic energy drops out and offers itself for immediate study.

MASS AND ENERGY

Einstein at once recognised other consequences of this identity of mass and energy. A bundle or packet of energy, for example, must behave like a mass and exhibit inertia. A beam of light, therefore, approaching the Earth along a line in close proximity to the Sun, must be deflected or bent. One of the most startling tests of this theory was made in 1919 by an expedition which set out to study an eclipse, when his estimate of the extent of this bending was almost exactly verified. This meant that a beam of light was subject to gravitational pull. It was a triumph comparable to the Adams and Leverrier prediction of the location of Neptune, that led to the discovery of that planet.

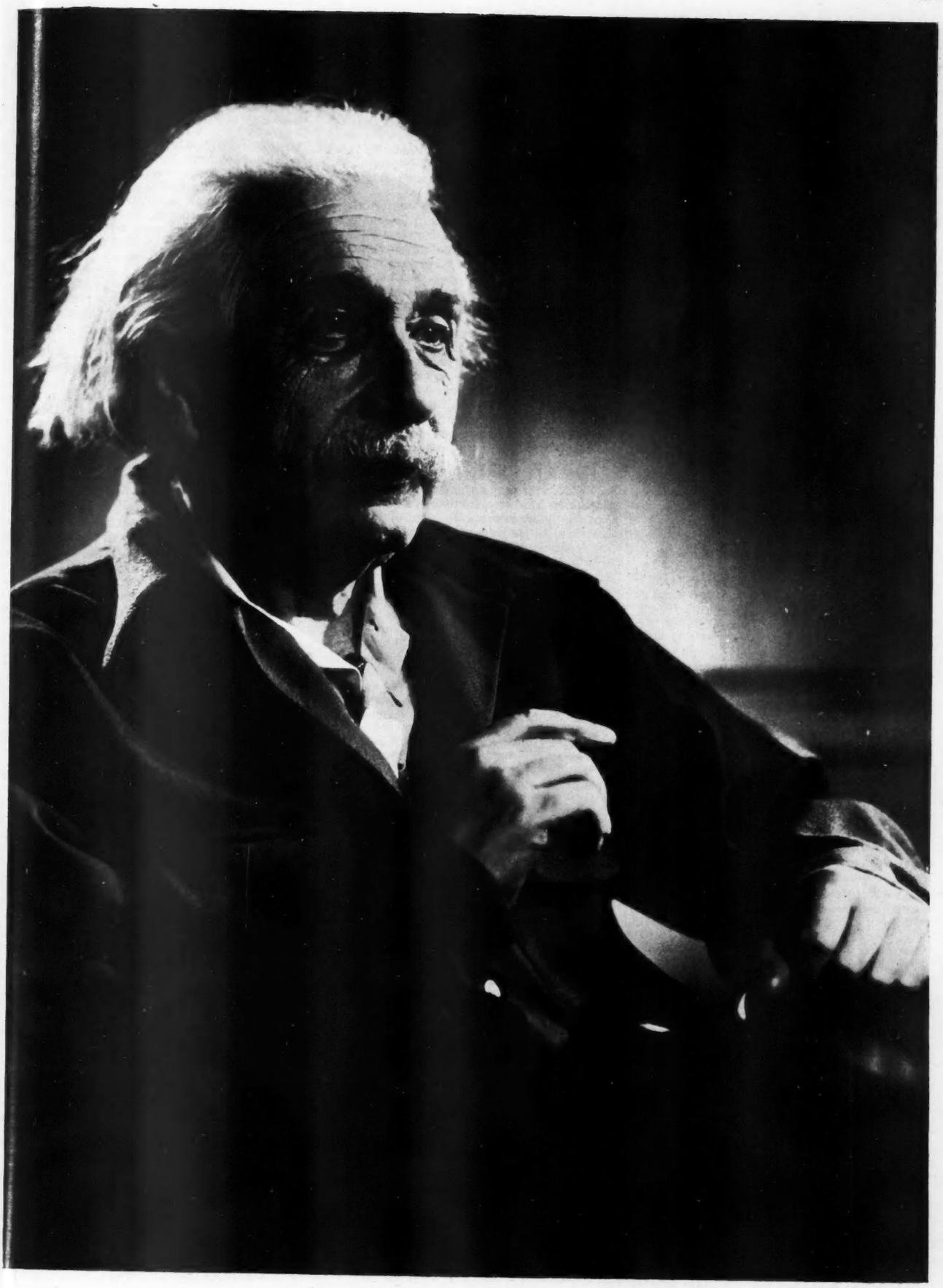
Any single one of these discoveries would in in itself have sufficed to perpetuate the name of this man in the history of science, but his restless searching mind pressed on, applying its revolutionary mode of thinking to new fields. It was natural that Gravitation, this isolated phenomenon that bridged space, should draw him to it. The idea of a field was not too strange. Clerk Maxwell had already linked into one totality the various outward manifestations of electricity and magnetism in which the "field" played as significant a part as the boundary elements that were usually regarded as responsible for the origin of the field itself. If a current is alternating in a wire, is there or is there not a corresponding magnetic field in its neighbourhood, or does it come into existence at a point only when a minute magnet is put there? This is reminiscent of Berkeley discussing whether the table exists when we are looking elsewhere. Fortunately, science has no room for the type of scepticism that is incapable of being put to the test of practice. To the scientist and engineer, Maxwell's equations described the behaviour of a perfectly real field located in the region around the wires bearing the current. Cause and effect were interchangeable; objective behaviour in terms of matter and motion was the important factor.

GRAVITATION

Einstein had approached the speed of light from this viewpoint. He had accepted it as a mode of physical behaviour and had followed up its consequences. Turning to gravitation then, he argued—here are lumps of matter in this space-time continuum. Here are smaller pieces in their neighbourhood moving along certain orbits. What kind of space-time, he asked, would give these paths as the *natural* mode of motion, in the same way as Newton had conceived of a particle in empty space as moving *naturally* along a straight line? The geometry we had learnt at school, the geometry of Euclid, was really a logical ordering of behaviour in our localised space—a static geometry in a flat isolated space. What kind of geometry would a real space-time exhibit when it has lumps of matter present in it? Here Einstein had a stroke of luck. The mathematicians had already investigated much of the geometry of a four-dimensional space, and had devised a particular symbolism, tensors, to assist them. What Einstein had to do was to master this symbolism, and reinterpret the findings in terms of actual motion of actual masses in order to discover the geometry of actual space-time. Instead of *causing* a gravitational pull, these masses were responsible for the geometrical properties of the four-dimensional space. In this way what appears to us as gravitation, acting mysteriously across our abstract isolated space, is simply part of his geometry. The space-time continuum was the "field" of gravity.

If we recall what was said earlier about the difficulties of popularisation we must not glibly brush this aside as the fantasies of a mathematician's mind. In fact, Einstein immediately scored another signal success. Everything that Newtonian dynamics could predict was embraced in Einstein's equations; what the Newtonians could not explain—the steady drift of the perihelion of Mercury and the unclosed nature of its orbit—were explained numerically by him. We need not enter further into his other developments of Relativity, nor need we explain the many profound discoveries he made in Quantum Theory once he had accepted Planck's Quantum Hypothesis regarding the discontinuous emission of energy. One thing is certain: that without Einstein's Mc^2 expression for intrinsic energy the history of nuclear power would have been very different.

A great mind has passed away, great in intellectual achievement and in human understanding. We at any rate can answer before history that we recognised and honoured his greatness during his actual lifetime.



[Karsh of Ottawa

Obituary

MAJOR F. B. HALFORD

Aircraft Engines and Gas Turbines

We record with regret the death on April 16, of Major F. B. Halford, C.B.E., F.R.Ae.S., M.S.A.E., chairman and technical director of the de Havilland Engine Company Limited, and a director of the de Havilland Aircraft Company, Limited, and designer of many famous aero-engines, both large and small, since 1915.

Frank Bernard Halford was born on March 7, 1894, and was educated at Felsted and Nottingham University. In 1913, he learned to fly at Brooklands and became an instructor at the Bristol Aeroplane School there. The following year he joined the Aeronautical Inspection Department at the Air Ministry as engine examiner. When war broke out in 1914, he joined the Royal Flying Corps and served in France, but the following year he was recalled in order to design a larger engine than the 160-h.p. Austin-Daimler engine developed by William Beardmore and Company.

On loan to the Beardmore company, he designed the B.H.P. (Beardmore-Halford-Pullinger) 230-h.p. vertical in-line six-cylinder watercooled engine which was used in early DH4 aircraft, and which thus initiated his association with the de Havilland organisation.

Towards the conclusion of the first World War Halford, in collaboration with Mr. (now Sir) H. R. Ricardo, worked on one of the first supercharged aircraft engines, the Ricardo Supercharger, a vertical-in-line engine. A V-12 cylinder version, the R.H.A., was subsequently developed by the Armstrongs company at Newcastle. About this time Halford conceived the idea of inverting the in-line engine to give the pilot a better forward view, and the Inverted Supercharger was flown successfully at Farnborough in a DH4, but its development was terminated by the end of hostilities.

From 1919 to 1923, Halford was with the Ricardo company and acted as their representative in the United States. In 1923, he set up his own design organisation in North Kensington; his sole staff was Mr. J. L. P. Brodie, now also a director of the de Havilland Engine Company, Limited. During this period he developed a 1½-litre six-cylinder 6 000 r.p.m. racing-car engine with which, installed in a Halford Special car, he won many races at Brooklands.

From 1924 to 1927, he designed, for the A.D.C. Aircraft Company, the Airdisco, Cirrus and Nimbus engines—the four-cylinder 60-h.p. Cirrus being designed for the de Havilland company and installed in their Moth aeroplane. When the de Havilland company decided to build their own engines, Halford designed for them the Gipsy engine, the various developments of which have given and are still giving reliable and lengthy service both in light aircraft and commercial air liners.

In 1927, in addition to working on the Gipsy engine for de Havilland, Halford engaged on the design of an H-type engine, the 305-h.p. 16-cylinder Rapier, for D. Napier and Sons, Limited. This was the first commercial application of the double crankshaft. Further developments on these lines were the Napier Dagger and, during the second World War, the Sabre which powered the Hawker Typhoon fighter aircraft. He was appointed technical director of the Napier company in 1935.

In 1940–41, Major Halford conceived the possibility of the single-sided centrifugal impeller and "straight-through" flow for the aircraft jet engine, as opposed to the Whittle conception of a double-sided impeller, and the de Havilland Goblin and Ghost jet engines were developed from these ideas. Thousands of these engines have been manufactured both in the United Kingdom and under licence overseas. The de Havilland Engine Company, Limited, was formed in 1944, with Halford as technical director. By this time he had given up his association with the Napier company. Under his leadership the research and development facilities of the engine company were built up to a standard as high as is currently possible. The company embarked on the development of liquid-fuel rocket motors and on a powerful axial-flow jet engine, the Gyron, which, in his last report to the tenth Annual General Meeting of the company, Halford described as "the largest jet engine yet announced," and revealed that its initial development was undertaken as a private venture.

In 1948, Major Halford was appointed C.B.E. in acknowledgment of a long and notable service to British aero-engine development. In 1951, he was elected President of the Royal Aeronautical Society for the year 1951–52; he had been a Fellow of the Society since 1927.

* * *

We regret also to record the deaths of:

MR. JAMES PARMLEY GRAHAM, A.M.I.Min.E., at Stocksfield, Northumberland, on April 11. Mr. Graham was chairman of J. Parmley Graham and Sons, engineers' agents, Newcastle-upon-Tyne, and had been associated with the electrical industry all his life. He was concerned in the first schemes for electrifying collieries in the North of England.

MR. JOHN FREDERICK FARQUHARSON, M.I.Struct.E., on April 5, at the age of 67. Mr. Farquharson was the founder and senior partner of the firm of John F. Farquharson & Partners, chartered structural engineers, 34, Queen Anne-street, London, W.1. He was a former member of Council of the Institution of Structural Engineers.

Dr. GEORGE HERBERT MILES, on April 4, at the age of 74. Dr. Miles, who was educated at Westminster College and the University of London, became secretary of the National Institute of Industrial Psychology in 1919, after war service in the Royal Navy. He was appointed assistant director in 1921 and was director from 1930 until 1937.

* * *

TELEVISION STATION IN NORTH SCOTLAND

The British Broadcasting Corporation have acquired a site for a North of Scotland television station about 11½ miles north-north-east of Inverness at a height of 680 ft. above sea level.

The new station, which is to be known as Rosemarkie, will cover about six acres and will serve an area which will include Inverness, Golspie, Bonar Bridge, Dingwall, Strathpeffer, Forres and Elgin. Transmission will be at 51·75 megacycles for vision and 48·25 megacycles for sound, and will be horizontally polarised. The site will also be suitable for the very-high-frequency transmissions of the Home, Light and Third programmes when it is possible to extend this system to this part of Scotland.

The new station is expected to be ready for service by the end of 1956.

FILMS AND HUMAN RELATIONS

Conference Organised by Scientific Film Association

A conference to discuss the subject "Film in the Improvement of Human Relations in Industry" is being organised by the Scientific Film Association with the co-operation of the International Scientific Film Association, and is to take place from Tuesday, May 24, to Thursday, May 26, of this year. The conference, which will be held at Ashorne Hill, near Leamington Spa, will include four main sessions each devoted to one of the following topics: films as introduction to a job, films on human attitudes to work, films as a means of communication within industry, and films for training in management-worker relations.

During each session one speaker will introduce the theoretical aspects of the problem and another will discuss the practical issues involved, and among those speaking will be Mr. M. J. Swanney, head of the teaching branch, National Coal Board, Dr. J. A. C. Brown, author of "The Social Psychology of Industry," Mr. Edgar Anstey, films officer and producer, the British Transport Commission, and Mr. F. Scarborough of Tube Investments Limited. The conference will be opened by Mr. Harold Watkinson, M.P., Parliamentary Secretary to the Ministry of Labour and National Service.

The Scientific Film Association exists to study, discuss, publicise and advocate the use of scientific films and to promote a wider understanding of science and the scientific outlook. Details of the conference may be obtained from its general secretary, Mr. A. M. Hughes, at 164 Shaftesbury-avenue, London, W.C.2.

* * *

NEW POWER STATION AT SKELTON GRANGE

The Central Electricity Authority have received the consent of the Ministry of Fuel and Power to establish a new power station at Skelton Grange, Leeds.

This station will be known as Skelton Grange B and will be built alongside the existing station (of which a description appeared on page 510 of last week's issue). It will house six 60-MW sets and the same number of 550,000-lb. boilers.

* * *

HYDRO-ELECTRIC AND DRAINAGE SCHEMES IN SOUTHERN IRELAND

Shortly after the outbreak of the 1939-45 war the Electricity Supply Board of Southern Ireland initiated a scheme for utilising the water of that part of the River Erne which flows through County Donegal for the generation of electricity.* In doing so it found that the resources available could be considerably increased if water could be drawn from Lough Erne in Northern Ireland. It therefore suggested to the Northern Ireland Government that this additional flow should be obtained by widening and deepening the outfall channel of the lake between Rosscor and Baleek, as well as by constructing a barrage to maintain the minimum levels downstream of Enniskillen and the removal of the existing barrage and sluices at Baleek. A new bridge at Baleek, the underpinning of the Rosscor viaduct and the improvement of the drainage round Upper Lough Erne, to prevent flooding between April and September, were also included.

Legislation covering these works was subsequently passed and the present position is that the widening and deepening of the outfall channel will be substantially finished by the end of next September. The new barrage at Portora is due for completion in January, 1956, the bridge at Baleek in November of this year and the Rosscor viaduct in a few months time. Good progress is also being made with the drainage scheme.

* ENGINEERING, vol. 173, page 774 (1952).

BOOK REVIEWS

Mathematics in Action. By PROFESSOR O. G. SUTTON. *G. Bell and Sons, Limited, York House, Portugal-street, London, W.C.2.* (16*s.*)

The increasing tendency to employ mathematical methods in specialised branches of engineering and physics is a consequence of the fact that mathematics gives to science the power of abstraction and generalisation, and a language that affords means of expressing ideas with the greatest possible clarity and conciseness. Thus, in penetrating deeply into the structure of theories, the mathematician is often able to discover common features, not obvious on the surface, and to remove barriers between specialised fields of research. In his book, Dr. Sutton, now Director of the Meteorological Office, explains how this endeavour to compress a mass of experimental data into a few differential equations has led to the development of pathways from basic principles to new experiments and speculations in various branches of applied science.

The first of the seven chapters in this book of 225 pages takes the form of an essay on the task of the mathematician, in which a special meaning is attached to the term "theory." In this the mathematician directs his attention to the problem of idealising a physical process, as distinct from a device to facilitate the discovery of solutions—that is, to investigations in which the properties of the system proposed affect significantly the conclusions reached. The most remarkable thing about this procedure is that there should be any correlation at all between the world of reality and that of the mathematician, but experience has shown that there is. The tools which the mathematician uses for this purpose are accordingly of particular interest, as the author next demonstrates in a masterly survey that ranges from arithmetic and algebra to differential equations and the principal equations of physics. After perusing this chapter the great majority of readers will readily appreciate the relevance of the concluding paragraph: "It is a strange thought that a few symbols, 'meaningless marks on paper,' have contributed so much to the shape of life as we know it today. A mediaeval scholar, awaking in our world, would recognise such symbols as spells, magic formulae which when properly pronounced confer power over the forces of Nature."

In the pages which follow, the author shows how this power has been attained, by reference to subjects in which he has worked, professionally, from time to time. Of these illustrative essays, the first deals with the external ballistics of a projectile, Siacci's solution of the ballistic equation being employed for the purpose of indicating how the trajectory is calculated, before the reader's attention is drawn to the utility of the more general step-by-step integration or solution by small arcs. Here the computer requires a working knowledge of numerical analysis and of calculating machines, for the reasons stated in the section under this sub-heading. The presentation of each topic is always simple and stimulating, as is perhaps best shown in the essay on waves, where the general principles of wave-motion are brought into close relation with radio signals and their reproduction, the theory of quanta, and the mathematical method of characteristics. The last of these topics brings under review the problem of bodies moving through air, and thus provides a direct link with the subject-matter of the next chapter, under the heading "The Mathematics of Flight." Of particular interest to the general reader is the author's description of how the fundamentals of fluid motion, streamline maps for ideal fluids and patterns of irrotational flow, enter into considerations of the dynamical problem and its solution, and of how our ideas have developed through the Lanchester-Prandtl theory of a finite aerofoil to the study of flight at supersonic speeds.

Chapter 6, on statistics, or the weighting of evidence, will appeal most of all to those in search of guidance on the meaning of distribution and dispersion, correlation, and sampling, and on applications of the normal statistical parameters. In the final chapter of this most attractive book, Dr. Sutton indicates the way by which the task of forecasting the weather has been reduced to the solution of certain mathematical equations, and why it is unlikely that any mathematical method can be evolved which will allow accurate predictions to be made for long periods.

Discontinuous Automatic Control. By IRMGARD FLÜGGE-LOTZ. *Princeton University Press, Princeton, N.J., U.S.A.* (5 dols.); and *Oxford University Press (Geoffrey Cumberlege), Amen House, Warwick-square, London, E.C.4.* (32*s.* 6*d.*)

Automatic controls have been used by engineers—as the author points out in her preface—at least since the invention of the centrifugal regulator for steam engines. To-day the use of controls is widespread, and they range in variety from the simplest domestic thermostat to such highly sophisticated systems as the automatic pilot for aircraft and the Denny-Brown stabiliser for ships. In most automatic installations the controlling "force" is applied continuously, with progressive variation in the amount of control exercised at any instant. The alternative is intermittent application of a constant controlling "force." This is the discontinuous control of the present context, which the author illustrates by describing the operation of a thermostat controlling the heating of a house, thus: "if the actual temperature is lower than the desired temperature by a certain amount, the furnace will start heating and stop the moment the desired temperature is reached." "Instruments of this type," the author adds, "are usually simply constructed and therefore less expensive."

This is a particularly good example of the general problem of control, because here is a case of convective heating in which cause and effect may be far from synchronous. It is a matter of common experience that, if the furnace is remote from the control point, the temperature will continue to rise after the furnace has stopped and it will continue to fall after the furnace has been restarted. The control can therefore never be exactly in phase with the disturbance of the desired steady state. Indeed, in one of the systems discussed in this treatise, the control and the disturbance are apparently pulling in the same direction. Hence one of the questions which has to be answered in the design of a discontinuous or "on-off" system is "when to switch." Obviously this cannot be a simple function of "position" alone, whether "position" stands for speed, temperature, direction or other physical parameter. It must also depend on the so-called "velocity," the time-derivative of "position," which may be acceleration, rate of change of temperature, or directional divergence manifested as rate of change of roll, pitch or yaw. The proportion in which "position" and "velocity" should be combined in the control function must therefore be determined as well as the timing of the switch operation.

In the mathematical analysis of control systems with one degree of freedom, the assumption of a second-order equation for the disturbed "position" together with a constant control, alternately positive and negative, leads to a solution which, in each interval between switch points, can be represented by part of a logarithmic spiral. With equations reduced to non-dimensional form, many different types of complete solution, composed of sequences of logarithmic spiral segments, are developed graphically.

The investigation was started with the object of finding whether discontinuous control could be developed for missiles, and the final chapter is devoted to consideration of the control of a moving body with more than one degree of freedom. But for the many engineers who may still be unconcerned with the development of guided missiles, the principal interest in this book will rest in the author's very elegant and exhaustive analysis of the unit problem. The immediate adaptation of the analysis to new design requirements is perhaps less obvious than the application to missiles. Before the methods presented here can be applied in practice, it is necessary to have accurate detection of position and velocity, and to be able to forecast the effect of a disturbance of the motion. In the aircraft and missile fields, instruments for velocity detection are available in the form of rate-of-turn and rate-of-roll indicators, whilst known aerodynamic coefficients can be used to establish the nature of a disturbed motion. In other applications the corresponding equipment and information cannot necessarily be taken straight off the shelf. Moreover, in problems concerning heat transfer a temperature-space gradient might have to be substituted for a temperature-time gradient in the basic analysis. But, whatever the application, there can be no doubt of the value of this fundamental monograph to any designer concerned with the possibility of solving a control problem by a discontinuous system.

Engineering Analysis: An Introduction to Professional Method. By D. W. VER PLANCK and B. R. TEARE, JR. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, N.Y., U.S.A.;* and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (48*s.*)

Engineering courses of university standard are rightly concerned with elaboration of the basic principles underlying mechanical science and of the techniques of application that are currently regarded as sound engineering practice. Especially under the second of these heads, new knowledge accumulates so rapidly that a course of reasonable duration offers little opportunity for engineering exercises along other than well-established lines. The authors of this book, both of whom profess engineering in the Carnegie Institute of Technology at Pittsburgh, appreciate how much existing information a student is nowadays required to absorb. They emphasise, nevertheless, as a major objective of engineering education, the development of a student's capacity to deal with quite unfamiliar problems by orderly, analytical thought combined with the application of the fundamental principles and engineering technology that he has learned.

Such, briefly, is the professional method which the authors illustrate, in the first part of their book, by examining some questions typical of what an engineer may encounter in his practice, and presenting in considerable detail the thinking, reasoning and (where applicable) the mathematical steps needed to reach a solution by a sequence of deductive processes. In these examples, stress is laid on the importance of accurately defining the problem before planning how to set about it; and, secondly, of checking, by common sense and engineering instinct as well as numerically, the trend indicated by each stage of the argument, no less than the final result. A valuable purpose of these examples is to promote understanding of the fundamental principles of engineering science. This aspect of the subject is amplified by a review of basic principles in mechanics, electricity and heat, and is followed by some practical suggestions for translating typical aspects of those principles into mathematics; in which connection a chapter explaining the solutions of the commoner differential equations is a useful source of reference. The importance, in engineering analysis, of a correct interpretation of a mathematical result justifies a review of ways in which dimensional methods, graphs and physical analogues can contribute to a fuller understanding, especially in a somewhat unfamiliar subject.

The book concludes with a set of problems, mainly in mechanics, hydraulics and electricity, intended for analysis along the lines developed and exemplified in the major text. These problems will be very helpful to engineering teachers who adopt the authors' ideas as a means of consolidating and testing the knowledge acquired by their students. In all probability, however, the class of reader most likely to benefit from a careful study of this book and its problems is the young graduate engineer in the early stages of an industrial career. He will find the subject challenging, stimulating and immediately rewarding in his professional work.

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in later issues of ENGINEERING.

Concrete Roads. *Cement and Concrete Association, 52 Grosvenor-gardens, London, S.W.*1. (Free on application).

A series of five booklets with the following titles and dealing with the various aspects of road building are now or will shortly be available from the Cement and Concrete Association. The titles are: No. 1, Earthworks, sub-grades and bases; No. 2, Slab design; No. 3, Design of mixes; No. 4, Construction methods; and No. 5, Soil-cement roads. It is intended that the booklets, which have been compiled by members of the staff of the Association, should present the lessons learnt from past mistakes and from research in a form suitable for application in the field. It is hoped that, with the assistance of the booklets, the highway engineer faced with the problem of building a road will be able to forecast how the work will be carried out when using the latest methods of design and construction.

Measures for Preventing and Fighting Belt-Conveyor Fires. By W. DE BRAAF and W. MAAS. Published by the Safety in Mines Research Establishment. *Ministry of Fuel and Power, Information Branch, Thames House South, Millbank, London, S.W.*1. (1*s.*)

This is a reprint of a short paper presented by two Dutch engineers at the eighth International Conference of Directors of Safety in Mines Research, which was held at Dortmund last year. It reproduces the regulations under which belt-conveyors must be operated in the State mines in Holland and describes the measures adopted for preventing the generation of heat. Methods of dealing with the fire hazard in the driving motor and its surroundings are also detailed and some information is given about the laboratory research which has been undertaken on the subject.

The Design Thickness of Concrete Roads. Road Note No. 19. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.*2. (9*d.*)

This Road Note reviews the present state of knowledge of design factors in concrete-road construction; the essential recommendations are summarised in a table listing the thickness and reinforcement required for a wide variety of traffic and soil conditions. For normal subgrades the thicknesses given range from 10 in. for very heavy traffic to 5 in. for light traffic. These thicknesses are reduced for stable subgrades and increased for roads or poor subgrades, the strength of which is given in terms of the modulus of subgrade reaction.

How to Read Workshop Drawings. By W. LONGLAND. Revised by E. W. TWINING. *Percival Marshall and Company, Limited, 19-20 Noel-street, London, W.*1. (3*s.* 6*d.*)

A practical guide to the ready understanding of the working drawings used in the engineering and allied industries.

The Association of Consulting Engineers: Professional Rules and Practice and Scales of Fees (Including Model Forms of Agreement). *The Association of Consulting Engineers (Incorporated), 36 Victoria-street, London, S.W.*1. (5*s.*; 2*s.* 6*d.* to members.)

The Association have republished their rules and recommendations with respect to the desirable relations that should exist between the consulting profession and their clients. The model forms of agreement are in four forms: (*a*) as they apply to civil engineering works; (*b*) to electrical and mechanical work, other than that covered by (*d*); (*c*) to structural work in buildings and other structures; and (*d*) electrical and mechanical installation work in buildings. Fees appropriate to each kind of work, and due to engineers of different status are listed.

Portugal. Overseas Economic Survey. By W. W. MCVITTIE. *H.M. Stationery Office, Kingsway, London, W.C.*2. (4*s.* 6*d.*)

This is a further publication in the series of Overseas Economic Surveys covering economic and commercial conditions in various regions. The survey gives particulars of the six-year plan for the development of Portugal and her overseas territories. It emphasises that British suppliers should realise that this market is becoming increasingly competitive. Appendices are included on Madeira and the Azores.

Biennial Report, 1953 and 1954, of the National Bureau of Standards. Miscellaneous Publication 213. *The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A.* (60 cents.)

This report covers the two-year period from July 1, 1952, to June 30, 1954. It consists of five sections: a general summary; a résumé of the Bureau's research and development achievements; a review of the testing and calibration programme; a discussion of the Bureau's various co-operative activities; and appendix material consisting mainly of statistical and organisational information.

The Diamond Tool Industry in 1954. *Industrial Distributors (Sales), Limited, Industrial Diamond Information Bureau, 32–34 Holborn Viaduct, London, E.C.*1. (No price given.)

This is the tenth report in the series on the diamond tool industry. It consists of 18 sections and the subjects covered include scientific aspects, hardness and microhardness, surface finish testing, fine boring and turning, and truing of grinding wheels. Each of the sections refers to outstanding work published during 1954, and, in some cases, during 1953. The literature referred to in the report can be obtained on loan (the United Kingdom), from the Bureau.

Simplified Design of Structural Steel. By HARRY PARKER. Second edition. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, N.Y., U.S.A.* (5·75 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.*2. (46*s.*)

Day-to-day routine structural design problems are discussed in terms of current American practice. The approach is simultaneously fundamental and practical, design procedures being analysed and the solution of each type of problem related to the appropriate basic principles of mechanics; mathematical methods are restricted to G.C.E. algebra. Properties of sections are given for structural members at present available in the United States and the examples are worked to American standards.

Symposium on Lateral Load Tests on Piles (With Supplement). A.S.T.M. Special Technical Publications Nos. 154 and 154-A. *American Society for Testing Materials, 1916 Race-street, Philadelphia 3, Pennsylvania, U.S.A.* (2·75 dols.)

This symposium and the supplement together present ten papers and the ensuing discussions on data derived from many tests on full-size piles and laboratory tests on model piles. The papers were originally presented at annual general meetings of A.S.T.M. in 1953 and 1954, and are now published in the hope that the studies will lead to the development of standard procedures for making tests of this type. A wide range of soil conditions, types of piles, and methods of loading are covered in the papers, particular reference being made to the design of cofferdams, water-front structures and silos. Mathematical analyses of the test conditions and results are included in each paper.

Protective Current Transformers and Circuits. By P. MATHEWS. *Chapman and Hall, Limited, 37 Essex-street, London, W.C.*2. (36*s.*)

This book is one of a series recommended for publication by the Technical Papers Panel of the British Thomson-Houston Company. It has been written for those concerned with the advanced theory and practice. Mathematical analysis is used as a basis for development; and the essentials of protective current transformers are classified, thus bridging a gap between their designers and those of protective systems. An attempt has been made to lay down an adequate theoretical groundwork and to illustrate its application to common practical problems.

The Institution of Production Engineers: List of Papers and Lectures presented to Sections. 1953–1955. *The Institution of Production Engineers, 10 Chesterfield-street, London, W.*1. (1*s.*)

The papers are classified according to subject matter, and the name of the lecturer, the session during which, and the section before whom it was delivered, and details of publication, if any, are appended. Separate sections list overseas papers and films, films shown in the United Kingdom, and the names and addresses of lecturers.

Who's Who in the Motor Industry. Second edition. *Who's Who in the Motor Industry, Saint Mary's-gate, Grimsby, Lincolnshire.* (27*s.* 6*d.*)

As well as detailed information on firms and personalities in the motor industry, this book includes miscellaneous information on associations, professional organisations, the Press and motor trade coverage, and biographies of motor journalists and editors. In this second edition, all the information included in the first edition has been revised and brought up to date.

Veröffentlichungen des Deutschen Stahlbau-Verbandes. *Stahlbau-Verlags, G.m.b.H., Ebertplatz 1, Cologne, Germany.*

Korrosionsschutz im Stahlbau. 1/54. (7·50 D.M.) A comprehensive review of methods for the protection of steel structures and components against corrosion, with comparative details of costs and efficiencies. The work deals with manual and mechanical methods —sand blasting by jet and centrifugal projection, and oxy-acetylene blast flame applied to completed structures and to component members before erection. After removing loose rust and scale by wire brush, the burner is passed over the rusty surface. Owing to the reducing action of the flame, the rust is chemically decomposed and the occluded moisture is driven out by the high temperature, thus loosening the film of rust. Paint films are also burnt by the flame to a loose residue. Protective coats are applied to the smooth, dry and warm surface. Complete installations for special purposes, e.g., treatment of steel railway wagons, are described and illustrated. The work also deals with metallic paints and coatings, metal wire spraying methods and equipment, automatic arrangements for the treatment of rolled sections, and zinc spraying for window frames. Examples are given of modifications in the design of structures to lessen the risks of corrosion. The work is illustrated.

Gestalteter Stahl. 2/54. A symposium of lectures presented at the Conference at Munich, March 26, 1954, relating to recent developments in the architectural treatment of steel structures. The contents include papers on: Steel Structures in Munich—Early Examples and Present-Day Practice; Structural Steelwork Design and Erection; Steel Frames anp Atom Bombs; Steel Superstructures in Austria; The Steel Window in Modern Building Practice; and Experiences of Post-1945 Superstructures. The principal point of common agreement disclosed by these papers and the discussions which followed was the necessity for closer collaboration between architects and structural engineers. Conclusions drawn from all available reports on atom bomb explosions indicate that steel framed buildings are less resistant to blast than reinforced-concrete structures.

Ansprache und Vortrag anlässlich der Ehrenpromotion an der Technischen. Universität Berlin-Charlottenburg. By ERNST CHWALLA. 3/54. (3 D.M.). An address and lecture given on the occasion of the conferment of the degree of Honorary Doctor of the Technical University of Berlin-Charlottenburg upon Prof. Dr. techn. habil. Dr.-Ing. Ernst Chwalla. After acknowledgements and thanks for the honour conferred upon him, the lecturer addressed his audience on open problems of statics awaiting solution, indicating ten subjects in certain fields of approach. They presented no fundamental difficulties, but demanded sustained effort and trouble, and to his knowledge had not yet been solved satisfactorily.

Betrachtungen über Theorie und Anwendung von Verbundkonstruktionen. By KONRAD SATTLER. 4/54. (4·50 D.M.). The knowledge and economic application of compound structures is of comparatively recent date, but important understanding has been gained in the theoretical field and much practical experience has been gathered. The paper is a brief review of the possibilities of application and permits a slight insight into the working principles. Numerous examples, illustrated with photographs, are considered theoretically.

Ergebnisse der Versuche und Messungen auf dem Gebiet der Verbundbauweise. 5/54. (7·50 D.M.) A review of the results of researches and measurements in the field of composite structures of ferro-concrete and rolled steel sections, forming separate but inter-related components, the resultant stresses on the structure or parts thereof being influenced by the different thermal conductivity of the two materials but having the same coefficient of expansion. Shrinkage and creep are discussed at length together with the Karlsruhe temperature test results and the influence of prestressing. The review gives the constitution of numerous sub-committees of DAST and DIN 1078, and the separate investigations relating to composite girders. A bibliography refers to the most important scientific work dealing with this new field of structural engineering.

Formazione del Truciolo Metallico. By F. ALBERTO ISNARDI. Second edition. *Ulrico Hoepli, Milan, Italy.* (2,600 lire.)

A revised and enlarged edition covering progress and development in metal cutting and turning up to December, 1953. The book deals with the mathematical considerations of the mechanics of metal cutting in the lathe, and compares the characteristics of the angles and nomenclature in use in Anglo-Saxon and Latin countries. A detailed summary is given of the principal contributions to the literature from 1877 to 1953. Details are given of local heating of the work to about 650 deg. C. in the lathe by gas flame or induced high-frequency current. Mention is also made of the turning of some non-metallic materials such as semi-plastic ceramic paste in the lathe, yielding faithful copies of long metallic cuttings. The work is illustrated with photographs, diagrams and tables.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Surface Roughness Scales. RUBERT & CO., LTD., Chapel-street, Levenshulme, Manchester. Standard rectangular stainless-steel and rounded carbon-steel specimen surfaces for roughness comparison by touch and sight. Various sets of specimens graded in accordance with B.S. 1134 : 1950 in micro-inches C.L.A. Advantages in comparison with electronic equipment: inexpensive, skilled operator unnecessary, use in workshop, stylus is soft (finger nail as opposed to diamond) hence less damage to test surfaces, moreover brain automatically accommodates wear on finger nail. Illustrated leaflet.

Hydraulic Lift Truck. SALISBURY PRECISION ENGINEERING LTD., 1 Buckingham Palace-mansions, London, S.W.1. "Sherpa-II" hydraulic lift truck capable of lifting a load of 5 cwt. to a height of 4 ft. 10 in. by means of hand-operated pump acting in conjunction with a roller chain and pulley; the pump incorporates a dual speed piston giving a more than double-speed platform lift when the load is less than 2 cwt.; in addition to the two main 12-in. wheels, extra castor wheels are located above and behind them to provide four-point support for level movement. Illustrated leaflet.

G.T.M.A. Handbook. THE GAUGE & TOOL MAKERS' ASSOCIATION, Standbrook House, 2-5 Old Bond-street, London, W.1. Sixth edition of the Association's handbook. Summary of objects and activities of the G.T.M.A.; list of the present 308 member-firms and a buyers' guide to their products; also a list of members of the British Power Press Manufacturers' Association, for which the G.T.M.A. provides secretarial services and accommodation. Handbook with index.

Sander-Polisher and Universal Saw. I. & G. MANUFACTURING CO., LTD., 31a Sloane-street, London, S.W.1. Electrically operated sanding and polishing tool, designed to reduce the labour involved in these and other rubbing operations; it has a stroke length of $\frac{3}{16}$ in., a speed of 12,000 strokes per minute, and is held in the hand when in use; it weighs 2¾ lb. Universal saw, designed to fit any electric hand drill which serves as the power source. Illustrated leaflet.

Calculating Machines. BULMER'S (CALCULATORS) LTD., Empire House, St. Martins-le-Grand, London, E.C.1. "Addo" electrically or manually operated calculating machines designed primarily for accounting and costing work; keys giving: repeat, correction, non-added record, duplex total, minus, sub-total and total; all working shown; Book-keeping and cash-till machines. Illustrated leaflet.

Industrial Consultants. NORRIS INDUSTRIAL CONSULTANTS LTD., 3 Unity-street, College Green, Bristol, 1. Technical consultant organisation providing services in the fields of mechanical, electrical, civil and production engineering; qualified staffs to deal with problems of manufacture, accounting, works management and overseas projects, together with a wide range of design and drawing-office facilities. Booklet outlining the services offered.

Bolts, Nuts, Screws and Rivets. BRITISH BOLT, NUT, SCREW & RIVET FEDERATION, 69 Harborne-road, Edgbaston, Birmingham, 15. Federation's year book entitled "Heads and Threads" (1955); includes list of constituent associations, member firms and a buyers' guide; also lists British Standard Specifications of interest in this field. Bound booklet with stiff cover.

Chain Spanners. INDUSTRIAL CHAIN SUPPLY CO., LTD., 625 Fulham-road, London, S.W.6. Mark III medium-duty and Mark IV heavy-duty "Gripital" chain spanners with grip capacities of 4-in. and 6-in. diameter and handles 9 in. and 15 in. long respectively. Illustrated leaflet.

Motors for Power Station Auxiliaries. ENGLISH ELECTRIC CO. LTD., Marconi House, Strand, London, W.C.2. Motors for power station auxiliaries; electrical and mechanical requirements to ensure continuous operation with a minimum of maintenance. Illustrated booklet.

Electron Diffraction Camera. EDWARDS & CO. (London), LTD., Manor Royal, Crawley, Sussex. A new type of electron diffraction camera based on the original designs of Professor G. I. Finch. Illustrated leaflet giving fundamental principles and details of construction.

Lighting Fittings. COURTNEY, POPE (ELECTRICAL) LTD., Amhurst Park Works, London, N.15. Fittings for fluorescent and tungsten lights. Over 120 different models listed in brochure.

CANADA: AN EXPANDING MARKET

OPPORTUNITIES AND DIFFICULTIES FOR BRITAIN

This is the first of two articles on Canada, in which the difficulties and opportunities of Canada as a market for British goods are discussed. The second article, which will appear in a subsequent issue, discusses the importance and extent of her natural resources.

Canada is one of the leading trading nations—fourth in order of importance for the value of exports, and the largest importer of manufactured goods in the world. The rapid growth in national wealth and population must necessarily mean a considerable increase in Canadian trade, which, with exports accounting for between one-quarter and one-third of total income, has already expanded substantially since the war. The population is now more than one-fifth larger than in 1945 and national production nearly one-third higher : by 1980 the population is expected to increase by about 10 million to 25 million, and gross national income threefold to about 65 billion dols. British exports to Canada have risen from about 250 million dols. in 1946 to about 453 million dols. in 1953 (see Table I) but this increase is proportionately far less than that recorded for other countries.

Canadian imports from the United States at 3·2 billion dols. in 1953 were nearly two and a half times greater than in 1946. British trade has, of course, been frustrated by the persistent dollar shortage: in the past few years the United Kingdom has had to pay between 200 and 400 million dols per annum more for imports from Canada than was earned from exports to Canada. Consequently, heavy restrictions have had to be placed on imports, and whereas before the war the United Kingdom was the largest single Canadian export market, it now accounts for only about 17 per cent. of total Canadian exports compared with 60 per cent. in the case of the United States.

Irritation over the British restrictions could easily and understandably make the Canadians less keen to buy British, but on the whole the effect of the dollar shortage has been to increase their receptiveness to British goods. The present heavy preponderance of trade done with the United States has many dangers. A high proportion of Canadian exports to the United States, mainly primary products such as timber and woodpulp, metals, fertilisers, cattle, fish, etc., have to compete with domestic United States products: a slump in the United States, accompanied possibly by import restrictions would thus have very serious consequences for Canada. The expansion in the Canadian economy in the next decade will have to be based on increased production and exports of the primary resources industries, and for some of these products including wheat, there is likely to be little market in the United States. Although, unlike many other developing countries, the Canadians do not place the major emphasis on the growth of their manufacturing industries, these must expand considerably, and there is little likelihood that their products will be able to compete very successfully in the U.S. market against those of U.S. manufacturers whose scale of production is very much greater.

DESIRE TO BUY FROM BRITAIN

Appreciation of these trends has caused the Canadians to seek means to increase their purchases from the United Kingdom and the Commonwealth. Many companies and public utilities, both independently and through their trade associations, have made detailed investigations of the possibility of increasing their purchases of British goods. The present deficit in British balance of trade with Canada is after all, fairly small in relation to United States exports, and should not be unbridgable if the Canadian goodwill can be matched by the enterprise of British exporters. It is worth enquiring whether a bolder British monetary policy might not achieve much. Cynics have said that British manufacturers turn to the difficult Canadian market only when trouble develops in easier markets where the non-convertibility of sterling has given them some protection. Certainly, there is an obvious temptation to concentrate sales effort in markets which yield the largest and quickest return: the acceptance of full convertibility, by stimulating sales in North America, might be the best way of curing the deficit in the dollar account.

Nevertheless, too rapid a move towards convertibility would be a rash undertaking without adequate assurance that Canada and the United States would in fact absorb a higher volume of British exports. For all their goodwill, Canadians can hardly be expected to buy British if British products of the right type and British service are not competitive with those of U.S. manufacturers. If Canadian development is following lines which favour products more suited to U.S. experience and production methods, then British exports might conceivably lose further ground relatively. It will therefore be necessary to enquire more closely into the pattern of Canadian development in order to see whether it presents worthwhile opportunities for British goods.

RISING INVESTMENT IN PRIMARY INDUSTRIES

The total Canadian gross national product in 1954, detailed in Table II, was about 24,000 million dols., which despite the recession was only 2 per cent. less than in 1953, and in real terms more than one-fifth higher than in 1949. Of this, domestic investment accounted for nearly one-quarter—a proportion substantially greater than is being achieved in any other Western nation including the United States. Although

TABLE I. CANADIAN TRADE (MILLION DOLLARS) (* January to November only)

Exports			Imports		
Principal Commodities	1953	1954	Principal Commodities	1953	1954
Newsprint	619	636	Industrial machinery	365	351
Wheat	568	375	Crude petroleum	192	194
Planks and boards	283	325	Electrical apparatus	181	186
Woodpulp	249	271	Automotive parts	204	166
Aluminium and products	178	185	Agricultural implements	201	136
Nickel and products	163	182	Petroleum products	133	119
Grain, other than wheat	225	137	Fruits	98	109
Copper and products	125	135	Coal	129	97
Fish and products	111	130	Aircraft and parts	103	91
Wheat flour	102	88	Steel rolled products	115	90
Asbestos and products	85	84	Engines and boilers	108	84
Agricultural machinery	74	77	Cotton products	85	70
Total, all exports	4,173	3,942	Total, all imports	4,382	4,095
Countries of Destination:			*Countries of Origin:*		
United States	2,463	2,363	United States	3,221	2,718*
United Kingdom	669	658	United Kingdom	453	359*
Other Commonwealth	248	205	Other Commonwealth	171	174*
Other European	373	346	Other European	173	164*
Latin America	199	188	Latin America	290	258*
Others	221	182	Others	74	83*

the bulk of Canadian investment is financed from local sources, about 15 per cent. of the funds come from abroad, mainly from the United States, and this further strengthens the hold of U.S. manufacturers on the market. British investment in Canada, although high in relation to what can be reasonably afforded for foreign investment by the United Kingdom, amounted to only 100 million dols. in 1953. It must not be assumed that because large spectacular projects for the development of petroleum, mineral and hydro-electric resources are being undertaken, Canadian investment must automatically increase. Some of the most important of these, the Quebec-Labrador iron ore development, the Kitimat aluminium and Lynn Lake nickel-copper schemes are already at the production stage, and although important new projects are on hand (including the St. Lawrence Seaway, the Chibougamau copper-gold development in Quebec, the Manitouwadge copper-zinc development of Lake Superior and the natural gas pipe line to Eastern Canada), these are still in their early stages, and Canadian "resources" investment is consequently temporarily reduced. In 1954, total investment fell back by about 6 per cent., and even in 1955 it is still expected to be about 30 million dols. short of the record total of 5,840 million dols. achieved in 1953. The increase, moreover, will come largely from heavier outlay on new housing. Outlay on primary resources in fact accounts for only about half the total investment (even assuming that all the expenditure on utilities and transportation can properly be classified under this heading). Canadian manufacturing industry has expanded more rapidly than the "resources" industries since the war, and as may be seen from Table II,

TABLE II.—*Canadian Income and Investment by Industry*, 1953. *Million Dollars.*

—	National Income.		New Investment	
	Million dols.	Per cent. total	Million dols.	Per cent. total
Agriculture	1,891	9·8	537	9·3
Fishing and trapping	60	0·3		
Forestry	326	1·7	35	0·6
Mining, quarrying and oilwells	721	3·7	280	4·9
Manufacturing	5,722	29·9	940	16·4
Building and construction	1,178	6·2	1,231	21·2
Utilities, transportation	2,025	10·6	1,168	20·3
Trade: Wholesale	939	4·9	285	4·9
Retail	1,766	9·1		
Finance, insurance, real estate	1,382	6·8	77	1·3
Service	1,459	7·5	419	7·3
Government departments	1,820	9·5	789	13·8
	19,289	100·0	5,761	100·0

about 36 per cent. of the national income derives from the manufacturing and building industries, 38 per cent. from trade, commerce and Government service, and only 26 per cent. from the "resources" industries. The pattern is, however, changing somewhat as may be seen from the comparison with the investment outlays. Outlay on agriculture, forestry and fishing was proportionately somewhat smaller than the income derived from these industries, but by reason of the heavy expenditure on hydro-electric power, roads, railways and mineral development, "resources" investment accounted for 35 per cent. of the total and manufacturing industry for only 16 per cent. According to the investment programme for 1955, outlay on plant and machinery will fall for the second successive year.

GROWTH OF MANUFACTURING INDUSTRIES

The concentration of investment on the "resources" industries is in keeping with the declared objectives of Canadian economic policy with its pronounced liberal bias. In Canada, the only justification for the establishment of a manufacturing industry is its ability to pay high wages and yield as great a profit as the "resources" industries. "Laissez-faire" principles are not, however, carried to extreme conclusions, and as in most other countries, established manufacturing industries which run into difficulties may well be able to enlist protection and official support. The most recent candidates for protection are the textile manufacturers who claim that the rapid increase in imports of British woollens is a serious threat to their industry. Manufacturing industries were particularly hard hit in the recent recession. Some, however, notably the paper-making and chemical industries, expanded; most, although they cut their labour forces, continued to pay high wages, and this, together with the rapid growth in population, prevented any serious fall in the Canadian national income in 1954. Prosperous manufacturing industries, growing up in close association with primary industry which provide both markets and raw materials have been a considerable asset to Canada. As may be seen from Table III, there are very wide differences in the wealth

TABLE III.—*Canada: Population, Personal Income and Wages in Manufacturing Industry by Provinces*—1953.

—	Population 1,000	Personal income million dols.	Income per head, dols.	Wages in manufacturing industry, million dols.
Newfoundland	383	249	650	26
Prince Edward Island	106	67	670	3
Nova Scotia	663	594	895	77
New Brunswick	536	406	755	60
Quebec	4,269	4,430	1,040	1,217
Ontario	4,897	7,175	1,470	2,015
Manitoba	809	921	1,140	122
Saskatchewan	861	1,101	1,280	32
Alberta	1,002	1,286	1,285	93
British Columbia	1,230	1,815	1,475	304
Yukon and North West territories	25			
	14,781	18,044	1,220	3,949

of the various Canadian provinces, and the poorest have relatively little manufacturing industry. Ontario, where income per head is more than twice as large as in Newfoundland, earns about 40 per cent. of the Canadian personal income and accounts for about half the investment in manufacturing industry. In investment in "resources" industries, Ontario comes second only to Alberta, and income per head in Alberta, which accounts for about 30 per cent. of such investment (but for only a very small proportion of investment in manufacturing industries), is only about the national average. While much is being done to open up the resources of the large Canadian hinterland it must not be forgotten that the bulk of the development work is being carried out close to the established population centres. In Ontario, the rate of growth of population of 150,000 a year (compared with 40,000 12 years ago) is greater than that of any other province, and double that of the United States.

These trends do not alter the fact that the "resources" industries are the keystone of the economy. Canadian primary products are competitive with those of any other country, and exports of most with the important exception of wheat (see Table I) have been expanding rapidly, while exports of manufactured goods have tended to decline. Canadian timber is the cheapest in the world, and exports of timber, pulp and newsprint have been particularly strong: exports of newsprint in 1954 were the highest ever recorded for any single commodity in Canadian history. Canadian exports of grain were perhaps abnormally high from 1950 to 1952 when excellent Canadian crops coincided with abnormally low production in the rest of the world, and the fall in 1953 and 1954 was thus to some extent inevitable: nevertheless, there is still considerable scope for increased exports of Canadian wheat. For all the rapid development of oil and other resources, wheat is still king of the prairies and productivity in this already highly mechanised industry continues to rise rapidly.

SPECIAL FEATURES OF CANADIAN MARKET

At first sight, the parallel growth of primary and manufacturing industries would seem to create the widest and most favourable opportunities for British exports—particularly of engineering goods. Engineering and metal products valued at £58 million accounted for 44 per cent. of British exports to Canada in 1954 (textiles, the next largest group, accounted for only 15 per cent.) They cover a very wide range of equipment: machinery for manufacturing industry perhaps accounts for the highest proportion, but under equipment for the "resources" industries, may be included large exports of vehicles and electrical machinery. Moreover, as is appropriate in a market where personal incomes are high, there are substantial exports of durable consumer goods including cars.

In all these categories, British exports are limited by some serious handicaps. The Canadian market for durable consumer goods is much more akin to the U.S. market than the British home market, the special peculiarities of which too often prevent British manufacturers from making products which will have the strongest appeal in Canada. Utility and economy considerations which so strongly influence the design of British consumer goods, produced in any quantity, whether textile, washing machines or passenger cars, are of much less account in Canada. Whereas in the United Kingdom, for example, the washing machines which sell in greatest quantity are of small dimensions, Canadian demand is overwhelmingly for machines of more ample proportions. The "economy" type car, upon which British manufacturers are to some extent basing their expansion programmes, is unlikely to find much of a market in Canada; and, although medium cars such as the Austin A40 type have sold well, it is doubtful if they will ever regain the position they held before Canadian and U.S. cars were available in sufficient numbers to satisfy most of the demand.

There is obviously no point in British manufacturers producing, specially for the Canadian market, goods which U.S. manufacturers supply in volume. The latter can either treat Canada as a direct extension of their home market, or where special conditions warrant it, set up subsidiaries across the border. U.S. development of this kind accounts for a fairly high proportion of the growth of manufacturing industry in Canada. Some British companies also have Canadian manufacturing subsidiaries but since British capital resources are more restricted than those of the U.S., British progress is comparatively slow. Nevertheless, this may be an indispensable approach in selling more to a market remote from the United Kingdom and with very different characteristics.

AFTER-SALES SERVICE

The establishment of a subsidiary capable of making at least some of the most important components may be one means of solving the spares and maintenance problem, which has been perhaps the most serious stumbling block to increasing sales of British engineering goods. The importance of the "spares" question, of course, varies according to the type of plant, and on the whole it may be less pressing for equipment sold to manufacturing industries such as machine tools, textile machinery, etc. These industries have skilled technicians and are generally prepared to carry spares themselves. Manufacturers of machinery for the "resources" industries and for some types of consumer goods, on the other hand, must be prepared to supply standard spares at the shortest possible notice. The services organisations of U.S. manufacturers are always most comprehensive, and even if British manufacturers are willing to undertake a comparable capital outlay, they may be thwarted through inability to obtain agents of the requisite standard. The best have long-established connections with U.S. manufacturers and will not easily change their loyalties. American manufacturers of earthmoving machinery, agricultural machinery, motor vehicles, etc., able to give 24 hours' service in even the remotest areas, are so strongly entrenched that it is extremely difficult for British manufacturers to make headway—even although their products may be substantially cheaper. When British

products have the backing of U.S. sales and service organisation (as is the case of British manufacturers with U.S. associates) they sell remarkably well—as witness the success of the British Ford Diesel tractor in both Canada and the United States.

Only time, patience and the willingness to undertake heavy capital outlay will thus enable British manufacturers to make any impression on the market for many types of products even although Canadian demand may be rising rapidly. There are, of course, many specialist or quality products such as sports cars and bicycles in which British manufacturers have peculiar advantages. Increased sales of these (and many more the potential of which is still unrealised) and also of many types of machinery for manufacturing industry, might go far in meeting the trade deficit with Canada. The increasing participation of British companies in development of Canadian resources either as principals or contractors is providing opportunities for showing how British equipment can compare in Canadian conditions with the established American types.

(*To be continued*)

The Institute of Metals Spring Meeting (*continued from page* 499)

CONTROL OF QUALITY IN WROUGHT NON-FERROUS METALS

HEAT-TREATMENT AND FINAL OPERATIONS

The discussion on a symposium of six papers concerning "The Control of Quality in the Production of Wrought Non-Ferrous Metals and Alloys. Part III.—The Control of Quality in Heat-Treatment and Final Operations," held during the spring meeting of the Institute of Metals, was concluded at the afternoon session, on Thursday, March 31. The chair was occupied by Mr. W. J. Thomas, M.I.Mech.E., chairman of the Institute's Metallurgical Engineering Committee.

Mr. F. King, who resumed the discussion, said that several of the authors had again made reference to the great importance of control in the early stages of fabrication. While this was accepted, the fact should not be overlooked that final operations were also responsible for a high percentage of the rejections encountered on final inspection.

Reference had been made to the possibility of the continuous annealing of aluminium and aluminium-alloy strip, and complications such as the joining of coils, had been mentioned. These complications were of a minor nature compared with those likely to arise from the handling of soft hot strip. Continuous annealing of strip had been practised in the copper and brass industry over a period of more than a quarter of a century, and it would be of interest to hear how this industry had dealt with the problems which had been encountered.

In the papers on the copper and nickel alloys, very little had been said concerning the methods for controlling quality in the pickling and cleaning operations. Some discussion on this subject would be welcome.

In dealing with the heat treatment of extruded and drawn products, Messrs. Field and Salter had expressed doubts as to whether or not the use of the vertical-type heat-treatment furnace for these products was entirely justified. In quenching tube from a horizontal type of furnace there was a risk of air becoming trapped in the tube and causing the load to become buoyant, resulting either in inefficient quenching or in serious distortion. This risk could be minimised by vertical heat treatment and quenching, and it has been found that, for tubes less than 1-in. in diameter, adequate straightening could be carried out after vertical heat treatment by stretching. For larger sizes of tube a drawing reduction of 5 per cent. after heat-treatment was all that was required.

Mr. Miller had stated that, as an alternative to batch furnaces, salt-bath furnaces could be used for the solution heat-treatment of wire. These salt baths might be satisfactory for wire heat-treated in the strand form, but salt baths were undesirable for the heat-treatment of coils of wire on account of difficulty with the removal of salt after quenching. Unless an efficient means of salt removal were employed, possibly by re-winding, serious corrosion problems were likely to be encountered. Moreover the oxide film formed during salt-bath heat-treatment could be a source of heavy die wear on subsequent manipulation, such as drawing or rivet-making.

Messrs. Field and Salter, and Messrs. Hysel and Collier, had stated that as long as steps were taken to maintain the amount of residual oil at a minimum, there was considerable freedom from burnt-oil stains. The solution to many oil-staining problems no doubt lay in the development of improved techniques for oil removal prior to thermal treatment. A study of the chemistry of oil breakdown in service and during annealing was also important, and the methods used for the control of rolling and drawing lubricants was a subject coming within the scope of the present symposium.

Mr. H. J. Miller, one of the authors, on being called upon by the chairman, said that vacuum-annealing plants had been marketed by at least two Continental manufacturers, and the greatest claim for them, apparently, was that they completely avoided the "stickiness" of wire which occurred in batch annealing. He did not think that anyone knew why this occurred, but it did occur, and in his paper, he had put forward the view that it might be due to the fact that there was an oxide film on the copper which was reduced by the hydrogen present in normal bright-annealing atmospheres, thus giving a highly activated form of surface. He had suggested that under the pressures involved there was a bridging across by certain crystals.

Dr. G. E. A. Bramley had referred to residual lubricants that left a film on aluminium wire, which then had to be rolled into strip and caused trouble with respect to the control of width. It was his impression that these residual lubricants arose entirely because very heavy mineral oils were customarily used for drawing aluminium wire. It pointed to the fact that further efforts ought to be made to develop water-soluble lubricants.

EDDY-CURRENT TESTING

Another author, Dr. W. Betteridge, said that the only specific point raised concerning their paper related to the use of eddy-current testing for the detection of defects in bars. The question was whether the method was applicable to bars other than those with a certain cross-section. Up till the present they had not used it for other than round-section bars, but it seemed clear that it would be applicable, even though the sensitivity would vary for defects at different points round the circumference of a bar owing to the variation in density of the eddy currents with the change in section. That, however, was only an opinion, and they had no direct information.

Continuing the discussion, Mr. N. I. Bond-Williams said that the separation of an inspection function into a watertight compartment, quite distinct from production and processing, was an organisational fallacy and one which metallurgists should not be tempted to accept simply because the inspectors told them that it was "a good idea." As controls were developed in the industry, both in equipment and in methods, so it was found that the persons who operated the machinery and supervised the processes had less and less to do except to look after quality. Eventually, if the development continued in the direction which he believed it to be taking, it would be found that the employees did nothing but control quality and that everything else would be done almost automatically.

Psychologically it was a great mistake to think of divorcing quality from the activities of the workmen. He agreed, however, that it was necessary to have an umpire who could say at the end whether something was right or wrong.

In the papers very little had been said about dimensions, and it was particularly difficult to measure, and therefore to control, the dimensions of soft materials. Solutions to this problem, however, had been found, and metallurgists should be encouraged to take a greater interest in the problems of dimensional accuracy, and particularly in solving some of the difficulties of measurement that were seldom tackled by production engineers, except in relation to hard materials, which did not present the same difficulties.

CALL FOR STANDARD SYSTEM OF GRAIN-SIZE MEASUREMENT

Mr. P. C. Murphy said that while all manufacturers and large users of aluminium alloys must have devised a system for standardising grain-size measurement throughout their organisation, it was unfortunate that there was no generally-accepted method given in published works, and, at times, it could be difficult to correlate various methods of expressing grain size. Grain shape varied with both temper and alloy, and this precluded the general use of standard comparison charts. The most complete method of specifying grain size was by giving the actual—namely, the spatial—average dimension of grains in each of three dimensions, describing if necessary any changes through the section.

Mr. R. T. Thorley stated that in the paper by Messrs. Field and Salter the comment was made that a low-silicon, high-iron content was conducive to a fine grain size in commercial-purity aluminium or in the 1¼ per cent. manganese alloy. While he agreed that an increase in iron led to a fine grain size, he wondered whether the authors implied that a low-silicon content was necessary from this point of view. His own experience was that silicon between 0·2 and 0·5 per cent. had very little effect on grain size. In fact, a statistical analysis on the 1¼ per cent. manganese alloy had shown high silicon to give a slight grain refinement.

Mr. R. C. Ansell stated that in the paper by Messrs. Field and Salter it was mentioned that it was customary to inter-leave sheets with tissue paper during packing. It was worth while considering in some detail the tissue paper used, as the cost was something like ½*d.* per square yard. In addition, the paper could give rise to corrosion problems, under certain conditions, during transit or storage. In the course of its manufacture the paper, whether chemically or mechanically digested, was always washed thoroughly with water, and the characteristics of the paper could be determined by the dissolved solids in the water remaining in the processed paper. Traces of such impurities as chloride or sulphate were dangerous from the corrosion point of view, since ordinary paper contained approximately 10 per cent. of water by weight and would readily absorb further quantities, giving the conditions for typical paper corrosion patterns on the sheets contacting the paper.

There were several ways in which this form of corrosion could be overcome. It was possible to control the acidity and chloride content of the paper which was purchased, and, for home use, it had been suggested that an acidity of not greater than 0·01 per cent., calculated as sulphuric acid, and a chloride content of 0·25 per cent., calculated as sodium chloride, should be stipulated. For exported material, however,

especially where higher humidities might be encountered, higher-quality paper must be used with an impurity level less than half that to which he had just referred. Alternatively, the tissue papers could be treated with a corrosion inhibitor such as sodium benzoate or sodium chromate, both of which could be extremely effective, but they increased the cost.

Another author, Mr. R. C. Lloyd, agreed with Mr. H. Chadwick that the only way of differentiating, with any certainty, between the different kinds of blister in drop forgings was by micro-examination, and the value of this examination in preventing the further occurrence of the types of defect mentioned had been emphasised.

Mr. A. J. Field, who was the last author to reply, said that his firm did have special demands for flatness. The trained eye was most effective in assessing it. Some sheets were put on a surface plate as the basic flatness, and a large scalped aluminium block was useful for this purpose.

On the question of the effect of iron and silicon on grain size, they agreed that silicon was not so important, but before the iron content was raised there was a grave risk that if the silicon were too high and the iron low, it would result in increased grain size, and so the iron-silicon ratio was brought into the picture. Much of the aluminium in commerce to-day had fairly high iron and fairly-low silicon and this gave a fine grain size.

(To be continued)

OIL FILM EXTENT IN COMPLETE JOURNAL BEARINGS

EFFECTS OF DIFFERENT OIL ENTRY SYSTEMS AND PRESSURES

By J. A. Cole, M.SC., A.M.I.MECH.E., *and C. J. Hughes**

In the case of the complete or 360-deg. journal bearing it has been known for some time that the load-carrying film extends over only part of the circumference, and the commonly accepted theory is that the film extends from the line of centres at the maximum film thickness position over an angle of between 180 deg. and 270 deg. The remaining 90-180 deg. of film is assumed to consist of cavitated oil, due to the tendency to produce sub-atmospheric pressures in the divergent film. When calculating bearing friction loss, however, this cavitated film is assumed to behave as a continuous film under simple shear, and conditions in the divergent region are generally a matter of speculation.[1]

An interest in film extent in complete bearings was stimulated by some results obtained at the Mechanical Engineering Research Laboratory (M.E.R.L.) for eccentricity, friction and oil flow. Two anomalous findings were that the friction was invariably lower than that calculated on the basis of a continuous film, and that the test bearing, which was free to tilt, gave different attitude-eccentricity loci at its two ends. This has led to an investigation of temperature distribution in journal bearings and to an examination of film extent in journal bearings, and some preliminary results of the second item are reported here.

EARLIER INVESTIGATIONS OF FILM EXTENT

The extent of the load-carrying film may be determined by measurements of film pressure at a number of pressure tappings in the bearing surface, but this method is not likely to give satisfactory results in the low-pressure regions of the film. Direct visual observation of the film is more promising, and results of its use have been published by Skinner,[2] Hamilton Gibson,[3] Hyde,[4] Barnard,[5] Vogelpohl,[6] Kolano,[7] and Banks and Mill.[8] Only Barnard, Vogelpohl and Kolano dealt with complete journal bearings, and they do not appear to have made extensive use of visual observation to study a wide range of variables with reasonably practical values o clearance, speed and load.

A satisfactory method of photographing oil film extent in complete 1-in. diameter bearings with standard clearance ratios (usually 0·001 and 0·002) has been developed at M.E.R.L., and measurements of film extent, oil flow and oil inlet and outlet temperatures have been made with a variety of conditions. Glass bearings are used, and the oil film is made to fluoresce by ultra-violet irradiation. The lubricant is a light mineral oil, viscosity about 6 centipoises at 60 deg. C. Speeds up to 5,000 r.p.m. and loads up to 200 lb. per square inch of bearing projected area have been employed. It is proposed to discuss the photographic results qualitatively here.

EFFECT OF SUPPLY PRESSURE

One of the simplest types of bearing is the complete bush with a single oil hole to admit oil opposite the point of application of the load.

Fig. 1 shows a bearing 1 in. in length by 1 in. in diameter by 0·002 in. diametral clearance running at 1,250 r.p.m. and 40 lb. per square inch load. The left photographs show the inlet film and the right photographs the outlet film, and the supply pressure increases from 0·6 to 26 lb. per square inch from bottom to top.

The inlet pattern is characteristic of the single-hole entry bearing under load, a film extending the full width of the bearing not forming for some distance after the oil entry, the amount depending on the operating conditions. The outlet film breaks down as the film diverges forming numerous streaks which travel round the bearing to re-enter the inlet film. The pattern flickers through minor variations while the bearing is running, but is fixed in its main outline for a given set of operating conditions. The effect of raising the feed pressure is to shorten the distance taken for the inlet pattern to achieve a full-width film, and, to a far smaller degree, to lengthen the outlet film.

Cutting off the oil supply altogether produces the effect shown in Fig. 2. The characteristic inlet pattern is replaced by an inverse pattern in which the inlet film is supplied with oil from the meniscus at each end of the bearing, and the end leakage oil recirculates to the meniscus. Eventually, the meniscus fails, and the inlet and outlet films shorten drastically, although the bearing may continue to run under fluid film conditions for some time. A drip feed produces an alternation between either of the patterns of Fig. 2 and the appropriate pattern of Fig. 1.

COMPARISON OF OIL ENTRY SYSTEMS

In Fig. 3 is shown the single hole oil entry already discussed, at a low and a high feed pressure. The loading cables are now at 45 deg. to the plane of the photographs to show inlet conditions more plainly.

Fig. 4 shows a single hole oil entry with an axial groove extending over 75 per cent. of the bearing length. At the low feed pressure, 0·6 lb. per square inch, the groove does not perform its intended function, and the oil entry pattern is characteristic of the single hole only. At the high feed pressure, 26 lb. per square inch, the axial groove gives a full width inlet film, and this extends back a little into the outlet film. Fig. 5 shows a single hole oil entry with the bush relieved over an angle $\pm$ 45 deg. for 75 per cent. of the bearing length, in the manner of a very wide axial groove. This gives a substantially complete film at both feed pressures, although at 0·6 lb. per square inch the trailing edge of the relieved area does not run full. This oil entry system gives the most oil flow for given operating conditions of the four systems described here. Fig. 6 shows a single hole oil entry with a complete circumferential groove. This gives a surprisingly short full width film even at the higher feed pressure. Adjacent to the groove a narrow complete cirumferential film is maintained.

Although the loads and speeds are similar in these photographs, variation of temperature with oil flow alters ZN/P* (Z centipoises, N r.p.m., P lb. per square inch load) to a small extent, and this, combined with the loading produced by the higher feed pressure, will cause the running eccentricity ratios to vary.

VARYING OPERATING CONDITIONS

A further twenty-eight photographs, which accompanied the original article but are not reproduced here, show three bearings, clearance ratio 0·001, length-diameter ratios $\frac{1}{2}$, 1, $1\frac{1}{2}$, with a single oil hole of fixed diameter, under various conditions of load and speed and with a feed pressure of 6 lb. per square inch. It has been found that the film pattern is, as would be expected, primarily determined by eccentricity ratio for a given feed pressure, and the three bearings are therefore compared on a ZN/P basis.

When ZN/P equals 120 and the bearing is fairly heavily loaded (ZN/P equals 20 would be very roughly the limit of hydrodynamic lubrication here), the full width film extends not a great deal over 180 deg., in reasonable agreement with the conventional assumption already mentioned. However, the equivalent area of the broken film is probably less than half that normally assumed in the same theory when calculating the viscous drag due to the low pressure region. Friction and temperature measurements are needed to investigate this further. Although the film patterns are similar for the three bearing lengths, the film extent does vary with length-diameter ratio.

As the loading decreases and ZN/P rises, the arc of the full width film lengthens, although this is masked in the photographs by the movement of the minimum film thickness position with changing eccentricity ratio. The full width film now starts later and finishes later than the theory suggests. At very high ZN/P, over say 1,000, especially with the two shorter bearings, the film is nearly complete apart from a few long bubbles in the centre, and here a speed effect is noticed, shaft rotation removing oil from the inlet film more rapidly than it can be supplied from the oil hole. In the longest bearing film breakdown is of this type but randomly distributed across the inlet film.

CONCLUSION

The photographs permit a detailed examina-

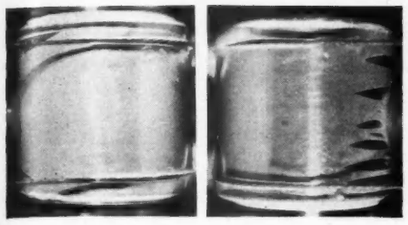
* Of the Lubrication and Wear Division of the Mechanical Engineering Research Laboratory, Department of Scientific and Industrial Research.

* Sommerfeld number = $2{\cdot}415 \times 10^{-8} \times$ ZN/P $\div$ (clearance ratio)^2.

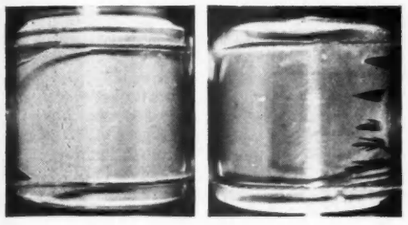
REFERENCES

[1] Cole, J. A., *Scientific Lubrication*, vol. 3, Part 1, pages 10–13 (1951).
[2] Skinner, S., *Proc. Phys. Soc.*, vol. 19, pages 73–80 (1905).
[3] Hamilton Gibson, J., *Trans. Inst. Naval Architects*, vol. 61, pages 248–253 (1919).
[4] Hyde, J. H., "Report of Lubricants and Lubrication Inquiry Committee," D.S.I.R., Appendix 16, pages 113–114 (1920).
[5] Barnard, D. P., *Ind. and Eng. Chem.*, vol. 18, pages 460–462 (1926).
[6] Vogelpohl, G., *V.D.I. Forschungsheft*, No. 386 (1937).
[7] Kolano, F. J., *Product Engineering*, vol. 24, No. 10, pages 162–163 (1953).
[8] Banks, W. H., & Mill, C. C., *Proc. Roy. Soc. A.*, vol. 223, pages 414–419 (1954).

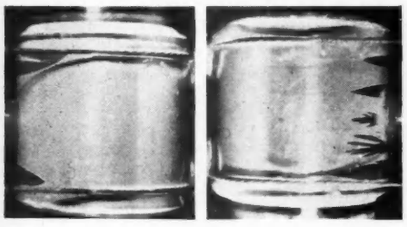
tion to be made of the effect of running conditions and bearing shape on film formation and rupture in journal bearings, and the present qualitative survey will be followed by a quantitative study of the subject, relating film extent, friction and oil flow. Preliminary indications are that the full width film begins and finishes somewhat later than is assumed in conventional theory. Under conditions of high speed and low load, the film is practically complete. The outlet film usually described as cavitated but assumed to be continuous when calculating its viscous drag, is shown to consist of filaments of oil covering only a fraction of the film. The shape of the entry film, as influenced by oil entry conditions, is clearly shown.



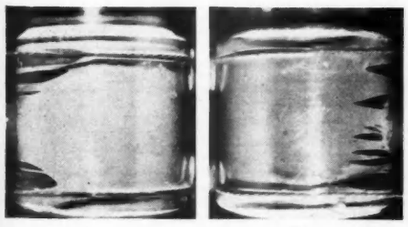
(*a*) Feed pressure 26 lb. per square inch.



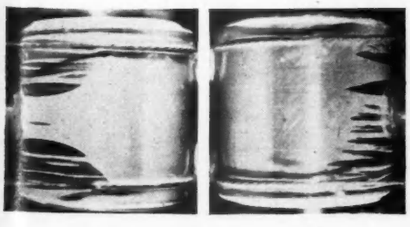
(*b*) Feed pressure 19 lb. per square inch.



(*c*) Feed pressure 11 lb. per square inch.



(*d*) Feed pressure 5 lb. per square inch.



(*e*) Feed pressure 0·6 lb. per square inch.

Fig. 1 Oil film extent in complete 1-in. diameter bearings at 1,250 r.p.m. and 40 lb. per square inch load.

ACKNOWLEDGMENTS

The work described has been carried out on behalf of the Director of Aeronautical and Engineering Research, Royal Naval Scientific Service, at the Mechanical Engineering Research Laboratory, Department of Scientific and Industrial Research. The paper is published by permission of the Admiralty, and the Director of Mechanical Engineering Research, D.S.I.R.

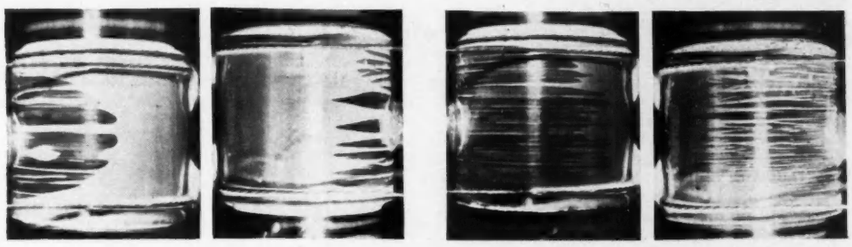


Fig. 2 The bearing under the same conditions as in Fig. 1, but with oil feed shut off.

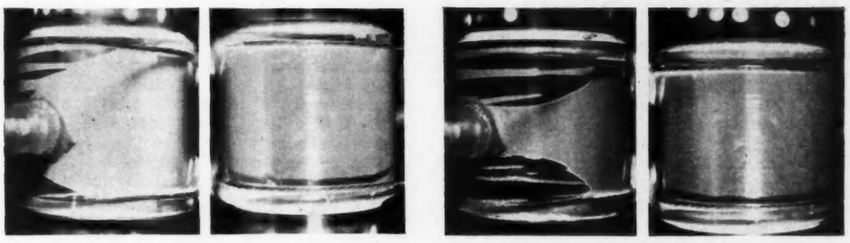


Fig. 3 The bearing under feed pressure of, left, 26 lb. per square inch, and right, 0·6 lb. per square inch, to show the inlet conditions more clearly,

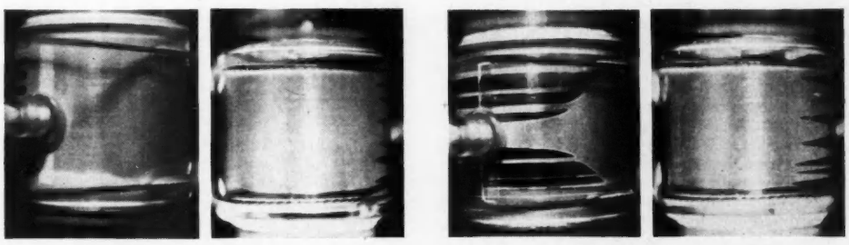


Fig. 4 Figs. 4, 5 and 6 show various systems of oil entry, and in each case the feed pressure in the left-hand pair of illustrations is 26 lb. per square inch, and in the right pair 0·6 lb. per square inch. In all cases the speed is 1,000 r.p.m. and the load 30 lb. per square inch. In Fig. 4, an axial groove extends over 75 per cent. of the bearing length.

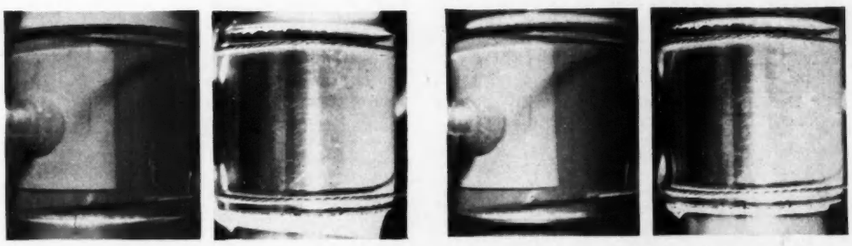


Fig. 5 Single-hole entry with the bush relieved over an angle of ± 45 deg. for 75 per cent. of the bearing length.

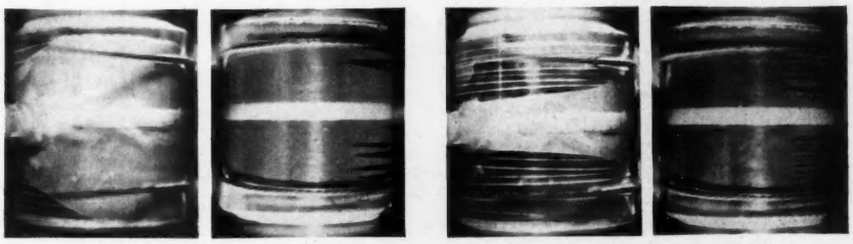


Fig. 6 Single-hole entry with complete circumferential groove.

In each pair of illustrations the left-hand one shows the "inlet" film and the right-hand one the "outlet" film.

FORMATION OF A HYDRAULIC JUMP IN A LONG UNIFORM CHANNEL

SIGNIFICANCE OF THE CRITICAL DEPTH

By B. A. Sutton, M.A.*

The problems of non-uniform flow in channels naturally present many more difficulties to the hydraulic engineer than does the simple case of uniform flow, and some misunderstanding occasionally results, particularly in respect of the theory of the hydraulic jump. For example, the statement is often made that the depth upstream of such a jump must be less than the critical depth for the quantity of water flowing in the channel. In fact, the necessary condition is stricter than this.

Consider a uniform channel of rectangular cross section. Let the width be B and let the quantity of water flowing be Q. Furthermore, assume that uniform flow is possible when the depth is H and that the slope is sufficiently small for H to be greater than the critical depth D_c, which is given by the well-known equation,

$$D_c = \sqrt[3]{\frac{Q^2}{g B^2}}.$$

If a hydraulic jump is assumed to exist at some point in the channel such that D_1 and D_2 are the depths just before and just after the jump, and V_1 is the mean velocity over the channel cross section just before the jump, the following equation is obtained from momentum considerations:—

$$D_2 = \sqrt{\frac{D_1^2}{4} + \frac{2 D_1 V_1^2}{g}} - \tfrac{1}{2} D_1.$$

Examination shows that, of the two depths D_1, D_2, one must be greater and one less than D_c. Also, if the smaller quantity is increased and made to approach D_c, the larger will decrease and approach D_c. In fact $D_1 = D_2 = D_c$ is a solution of the equation.

If D_1 is assumed to be less than D_2 it is found that there is a loss of energy which may be accounted for by eddy formation. If, on the other hand, D_1 is assumed greater than D_2 a gain of energy would occur and this is not physically possible. Thus energy considerations show that $D_1 < D_2$.

Combining these results we have $D_1 < D_c < D_2$, that is, the depth of liquid must increase from below the critical depth to above the critical depth through a hydraulic jump.

We should not, however, leave the question here. The differential equation giving the rate of increase of depth D with distance measured along the channel in terms of the slope i, the loss of head per unit length, h_f, and the local mean velocity, v, is

$$\frac{dD}{dL} = \frac{i - h_f}{1 + \frac{v}{g}\frac{dv}{dD}}.$$

It can be shown that $\frac{dD}{dL}$ is positive if $D < D_c$ or $D > H$ and negative if $D_c < D < H$. We thus have three types of flow. The specific energy $\left(D + \frac{v^2}{2g}\right)$ for some discharge Q is shown in Fig. 1. The trends of the three types of flow are shown by the arrows. If we had a hydraulic jump with D_1 only slightly less than D_c, D_2 would be only slightly greater than D_c and less than H. The depth and specific energy would decrease downstream so that there would be insufficient energy to obtain uniform flow and to get the liquid away, the build up of liquid forcing the hydraulic jump upstream. Before the jump, D is less than D_c and is increasing downstream. Thus, forcing the jump upstream decreases D_1 and this process will, if possible, continue until D_1 is decreased to such a value that $D_2 = H$. This value of D_1 will be designated D_0 and is shown in Fig. 1; D_0 is given by the expression

$$D_0 = \sqrt{\frac{H^2}{4} + \frac{2 H V_2^2}{g}} - \frac{H}{2}$$

where V_2 is the mean velocity when the depth is H.

This state of affairs is sketched in Fig. 2, where the depth of flow is reduced to below D_0 by a sluice. If the sluice opening is greater than D_0 the hydraulic jump could not be formed and a flow as sketched in Fig. 3 would occur. Thus, neglecting effects due to contraction of the stream issuing from the gate, the type of flow obtained depends on whether the opening is greater or less than D_0 and not on whether it is greater or less than D_c.

The foregoing discussion assumes that the channel is long and of uniform slope. If there were a drop in the bed or an increase of slope a short distance downstream, it might be possible for D_2 to be less than H and for D_1 to exceed D_0, as shown in Fig. 4. On the other hand some obstruction downstream might require D_2 to be greater than H and consequently the value of D_1 would have to be less than D_0, as is illustrated in Fig. 5.

A very weak hydraulic jump, that is, D_1 slightly less than D_c, could only exist near a drop in the bed or an increase in slope.

Thus, although it has been shown that the formation of a hydraulic jump is only possible when the upstream depth is less than D_c, it has also been shown that in a long uniform channel the depth must be reduced to below D_0.

The author would like to suggest the adoption of the term " bi-critical depth " for D_0.

* Department of Mechanical Engineering, Royal Military College of Science, Shrivenham.

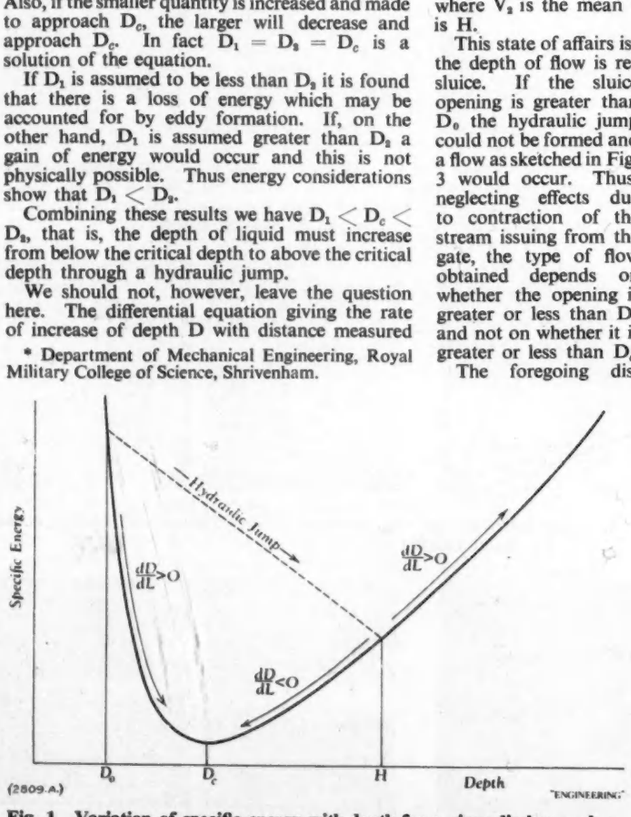
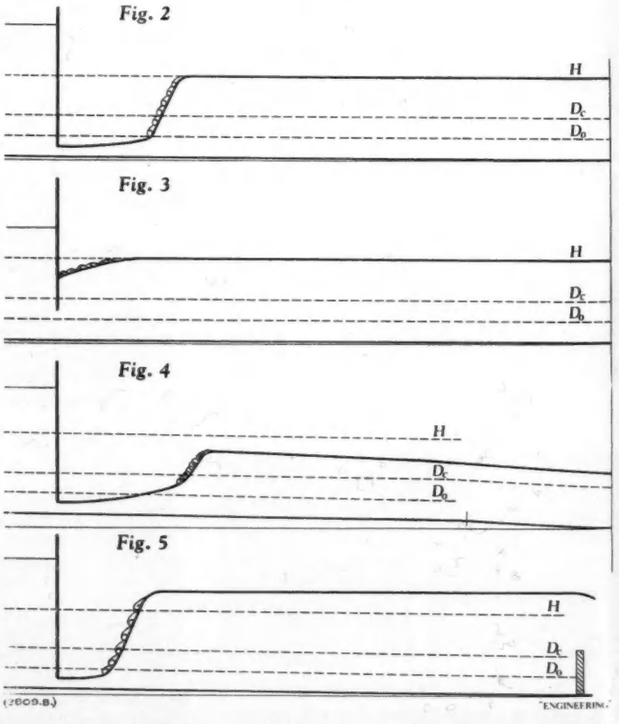


Fig. 1 Variation of specific energy with depth for a given discharge along a uniform channel, showing the three types of flow according to whether the depth of flow, D, is less than the critical depth, D_c, greater than the uniform depth, H, or between D_c and H.



Figs. 2 to 5 Following a sluice opening, the formation of a hydraulic jump is conditioned by the depth of the sluice opening and the presence of a change of gradient (Fig. 4) or of an obstruction (Fig. 5) downstream.

HYDRAULICS CONFERENCE

Iowa Institute, June 1955

Flow measurement has been selected as the theme of the Sixth Hydraulics Conference to be held at the Iowa Institute of Hydraulic Research, United States of America, from Monday, June 13, to Wednesday, June 15 next. Fourteen papers are scheduled for the five technical sessions and in a sixth session laboratory facilities will be demonstrated with special reference to the methods mentioned in the papers. Continuing the practice of earlier conferences, a volume of the *Proceedings*, containing the papers and a résumé of the discussions from the floor, will be published in the following year. In conjunction with and immediately following the conference there will be an intensive three-week course in experimental techniques.

★ ★ ★

In the Weekly Survey note " Railways in Asia," published in the issue of February 11, the title of the training centre in Lahore should have been the United Nations (not National) Railway Training Centre.

CHEAPER AND MORE RELIABLE MARINE MACHINERY

COMBINATION OF GAS TURBINE OR DIESEL ENGINE WITH STEAM

If Great Britain is to retain its position in the shipping world, the cost of producing and running British ships must be reduced. This view was expressed in a paper entitled "Marine Machinery of the Immediate Future from the Shipowner's Point of View," given by Mr. J. E. Church, F.C.M.S., M.I.N.A., principal superintendent of the South American Saint Line Limited, Cardiff, on April 12, to the Institute of Marine Engineers. Extracts from the paper are given below.

Shipowners at the present time are beset by severe economic difficulties because of the cost of building new ships and of running existing ships. It has been said that the British Merchant Navy faces slow extinction, and the British percentage of world tonnage is certainly declining. The shipbuilder and marine engineer can help to combat this decline by devising cheaper methods of running and cheaper initial construction. The cost of building a ship naturally depends largely on the duty for which it is intended, and as a representative of a fairly wide cross-section of present-day tonnage, a 10,000-ton deadweight 14-knot dry cargo vessel has been selected for investigation.

The average operating costs of this type of vessel are shown in Fig. 1, which gives each item as a percentage of the total on a voyage basis.

TECHNICAL AND HUMAN FACTORS

The factors in deciding what system to adopt may be summarised as follows. The present very high price of building is such that smaller, more concentrated and therefore less costly engine types must be considered, and the prime mover should be divided into two or more units, because the ship now becomes too valuable, and the daily cost of running too high, for it to be dependent on only one engine. Depreciation and loss of interest on capital have now become a large item. A reduction in the initial cost of machinery, even at the expense of a slight increase in fuel consumption, may have to be considered, particularly if the machinery is lighter, giving increased deadweight earning capacity, or the machinery is smaller, giving increased cargo cubic capacity. Cheaper, smaller, and lighter machinery can generally only be achieved by adopting higher power output ratings, which may result in increased repair and maintenance costs and a falling off in reliability. This may be acceptable providing multiple units are adopted (which also give desirable standby machinery) and one of these, up to about two-fifths of the total power, but not less than 2,000 h.p., must be of absolutely dependable reliability, such as a steam engine or turbine. A further consideration is that the heavier fuels at present used in some Diesel engines are not ideal for Diesel engines, and are more properly used for firing steam boilers. By a combination of machinery it would be possible to use oils for the purposes for which they have been blended. and still keep fuel costs low.

Another most important point is the human aspect of marine machinery operation. No matter how clever or brilliant an engine design may be, it depends upon human beings to watch over it day and night, who must care for it and diagnose and remedy its aches and pains. Unless everything in the engine room is reasonably straightforward and free from unnecessary complication, generally workmanlike and shipshape, does not impose too much upon human endurance in such matters as heat, noise and vibration, and is laid out with plenty of light, air and space for freedom of movement, then, human nature being what it is, neglect will result and serious trouble will follow. All too often this happens, and it is useless for an engine builder or designer to point an accusing finger at the ship's engineer for neglect of his engines; rather may he be to blame for failing to realise that sea-going engineers are human, and to compensate for the privations of a life at sea engine rooms must be made more than usually pleasant places in which to work.

FOUR MIXED SYSTEMS

To fill these requirements in varying degrees four proposals have been drawn up for a typical 10,000-ton cargo vessel of 5,300 shaft horsepower, which would give a speed of 14 knots, as follows:

A. Twin two-stroke cycle single-acting medium speed geared Diesels. This is an orthodox machinery type which has already been at sea in limited numbers for some years.

B. Enclosed-crankcase reversible double-compound steam engine in conjunction with non-reversible supercharged four-stroke cycle single-acting Diesel engine, both running at medium speed and driving the propeller shaft through hydraulic couplings and single-reduction gearing; Diesel exhausting through waste-heat section of steam boilers; astern power on steam engine only.

C. Triple-expansion steam reciprocating engine taking steam from a single water-tube boiler in conjunction with twin four-stroke cycle single-acting non-reversing turbo-charged fast-running Diesel engines, driving through hydraulic couplings and single-reduction gearing and exhausting through waste-heat economiser for steam boiler; astern power on steam engine only.

D. Ahead and astern single-casing double-reduction geared steam turbine in conjunction with open-cycle gas turbine which would be ahead only and drive through disconnecting hydraulic coupling into the same gearbox. The gas turbine would exhaust to the boiler furnaces, which would be arranged for alternate firing with heavy fuel oil, either independently or by after-burning in the gas stream. Astern power would be by steam turbine only. A diagram of the layout of this scheme is shown in Fig. 2.

Comparative running costs are shown in the accompanying table, in which a high-pressure turbine steamer and a direct-drive opposed-piston motorship have been included. The gas/steam turbine of Scheme D is the cheapest to use, and gives the greatest deadweight available for cargo. The direct-drive opposed-piston motorship is the next best on both points, but

SUMMARY OF COMPARATIVE DAILY OPERATING COSTS, ENGINE WEIGHTS AND CARGO SPACE, RESULTING FROM PROPOSED MACHINERY ARRANGEMENTS

—	Scheme A Twin geared Diesel	Scheme B Combined geared steam and Diesel	Scheme C Triple-expansion steam and Diesel	Scheme D Gas and steam turbines	High-pressure turbine steamer	Direct-drive opposed-piston motorship
Fuel, cost per day, £	225	252	257	230	271	217
Wages, cost per day, £	74	70	70	68	68	74
Repairs, cost per day, £	19	16	16	13	11	18
Depreciation, cost per day, £	98	76	72	83	91	97
Total cost per day, £	416	414	415	394	441	406
Fuel consumption, tons per day	22	33·5	33	27·5	43	21
Ship weight, tons	4,050	4,050	4,050	4,050	4,050	4,050
Machinery weight, tons	747	641	627	487	510	744
Lightship weight, tons	4,797	4,691	4,677	4,537	4,560	4,794
Displacement, tons	14,750	14,750	14,750	14,750	14,750	14,750
Total deadweight, tons	9,953	10,059	10,073	10,213	10,190	9,956
Less bunkers for 25 days, tons	550	837	825	687	1,075	525
Deadweight available for cargo, tons	9,403	9,222	9,248	9,526	9,115	9,431
Engine room length	52 ft. 6 in.	55 ft. 0 in.	48 ft. 0 in.	60 ft. 0 in.	62 ft. 6 in.	62 ft. 6 in.
Cubic capacity for cargo, cu. ft.	656,610	652,110	665,360	637,360	632,860	632,860

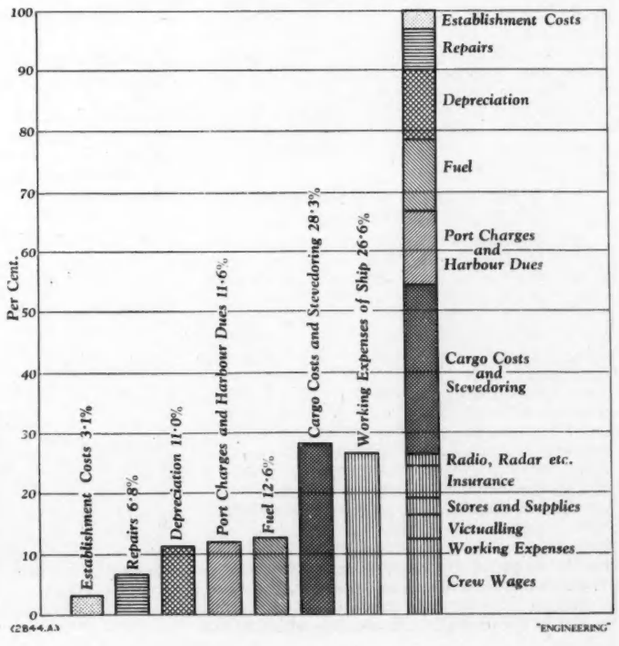


Fig. 1 Operating costs of a typical 10,000-ton 14-knot cargo ship as a percentage of total voyage expenditure show that depreciation forms nearly as great a part as fuel.

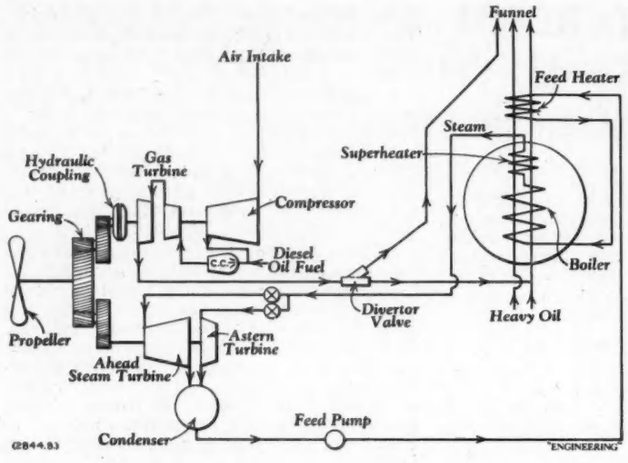


Fig. 2 Heat cycle diagram for combination gas/steam turbine marine machinery; astern power is by steam, and the gas turbine can be disconnected by the hydraulic coupling.

it must be remembered that these figures are during voyages only. The cost of depreciation will occur on every day of the year, and the opposed-piston motorship and the twin geared Diesel vessel of Scheme A are appreciably the most expensive in this respect.

Gearing and hydraulic couplings form the centrepiece of all the proposed multi-engined arrangements. Suitable gearing is now well developed and tried, as is also the hydraulic coupling, and it is obvious that the gas turbine in any form for marine propulsion other than electric drive will depend upon their use in some form. The developments of marine machinery suggested here may only be a temporary measure before the use of atomic power for main propulsion, but development should be rapid so that future orders can be speedily placed and the decline of the British Merchant Navy arrested.

180-MW POWER STATION AT EAST YELLAND

ADDITION TO GENERATING CAPACITY IN THE SOUTH-WEST

The East Yelland power station of the Central Electricity Authority, which was formally opened by the Lord Lieutenant of Devon (the Rt. Hon. the Earl Fortescue, K.G.), on Thursday, April 21, is the first large public coal-burning station to be operated in the Barnstaple-Bideford area. A supply of electricity has hitherto been obtained from Diesel engine driven plant. The site was selected owing to the excellent rock foundation, which consists mainly of sandstone; the availability of cooling water from the Taw estuary; and the fact that coal can be shipped direct from South Wales. When completed the station will contain six 30 MW sets of which three are now in operation. The foundations of the second half of the station have however, been completed and the erection of the superstructure is in hand. An exterior view is given in Fig. 1.

BUILDING AND CIVIL ENGINEERING WORK

The foundations have been constructed on the rock in reinforced concrete by Taylor, Woodrow Construction, Limited, Southall, Middlesex, while the main buildings, which were erected by John Lysaght's Bristol Works Limited, Bristol 2, and Staverton Builders, Limited, Totnes, Devonshire, consist of structural steel frameworks with brick walls and reinforced-concrete floors and roofs. The coal jetty, for which the contractors were Charles Brand and Sons, Limited, 25 Charles-street, London, S.W., is also of reinforced concrete. It runs parallel to, and about 400 ft., from the existing sea wall and its foundations consist of two rows of piers which are formed of tubes with an internal diameter of 4½ ft. The deck slab, which is 40 ft. wide, was cast *in situ*. The jetty is connected to the shore by a bridge of lighter construction, which is 17 ft. 2 in. wide and carries a 10 ft. roadway.

The circulating water inlets are incorporated in the jetty structure and are connected to the pumphouse by two 6 ft. 6 in. diameter tunnels. From this house a twin inlet culvert of reinforced concrete has been laid under the boiler house and is divided laterally along the two halves of the turbine house. The corresponding outlet culverts are combined at the centre of the station and run thence as a twin culvert to the outfall.

The coal-handling plant, which has been designed to meet the requirements of the finished station, at present comprises two electrically operated telpher transporters, each with a capacity of 150 tons per hour, which were manufactured by Strachan and Henshaw, Limited, Bristol, 5. These transporters, which are illustrated in Fig. 2, deliver coal from the colliers at the jetty to a system of belt conveyers with a capacity of 300 tons per hour which were supplied by Spencer (Melksham), Limited, Melksham, and run either direct to the boiler house bunkers or to a store with a capacity of about 90,000 tons. Coal is recovered from this store by a drag scraper with a capacity of 250 tons per hour at a mean radius of 165 ft. and is discharged to the main conveyer system.

STEAM RAISING PLANT

The steam raising plant at present installed consists of six stoker-fired boilers, while five similar units will eventually be housed in the extension. Each of these boilers, which were constructed by John Thompson Water Tube Boilers, Limited, Ettingshall, Wolverhampton, have a maximum continuous output of 180,000 lb. per hour at a pressure of 630 lb. per square inch and a temperature of 865 deg. F. They are of that firms radiant type with three drums including the steam receiver, the effective heating surface being 19,940 sq. ft., the area of the bare tube water walls 6,300 sq. ft. and the combustion chamber volume 12,100 cub. ft.

Associated with each boiler is a superheater with a heating surface of 6,360 sq. ft., the temperature in which is controlled by pyrometer and servo mechanisms. Butterfly valves in the steam connection between the primary superheater outlet and the secondary superheater inlet headers provide automatic control. There is also a hose tube steaming economiser with a heating surface of 11,580 sq. ft. and two regenerative rotary pre-heaters, the surface of which is 15,120 sq. ft.

There are two forced-draught and two induced-draught fans on each boiler. The former are of the single-inlet centrifugal type with a capacity of 30,800 cub. ft. per minute at 5·5 in. water gauge, while the latter are of the double-inlet pattern with a capacity of 47,800 cub. ft. per minute at 10·65 in. water gauge. There are also two secondary air fans on each boiler, the capacities of which are 8,150 cub. ft. per minute at 12 in. water gauge. All these fans are driven by direct-current motors, the fields of which are supplied at 130 volts and the armatures at from 0 to 550 volts from mercury arc rectifiers. The grids of the rectifiers supplying the armatures can be adjusted from the boiler gauge board by a motor-driven phase-shifter, thus allowing the speeds of the motors to be simultaneously varied and so ensuring optimum operating conditions at any load. Combustion is controlled by a manual centralised system, which provides simultaneous adjustment of the fuel supply and the draught. Automatic soot blowers are installed in both the boilers and air heaters.

The gases are discharged into a reinforced-concrete chimney which was built by Tileman and Company, Limited, 203 Knightsbridge, London, S.W.9. To meet Air Ministry requirements, this is at present only 117 ft. 6 in. high. It has, however, been designed so that it can later be increased to 214 ft. A similar chimney will be constructed for the second half of the station.

Ash and riddlings from the boilers are discharged on to belt conveyers, which are submerged in water troughs. These discharge on to an inclined open belt conveyer at the centre of the station, whence they are delivered into a bunker. Dust and grit from the boilers, economisers and chimney are removed by a vacuum system to tanks where they are wetted for convenient disposal. These portions of the plant were supplied by the John Thompson

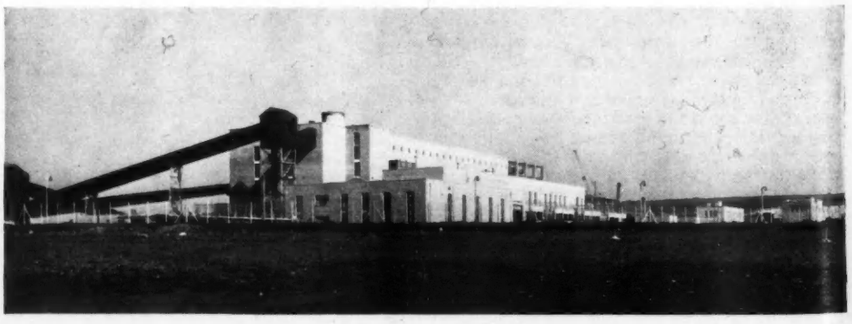


Fig. 1 Exterior view of East Yelland power station, which has been built by the Central Electricity Authority near Barnstaple.

Fig. 2 Coaling wharf at East Yelland power station, showing the telpher transporters and the belt conveyer.

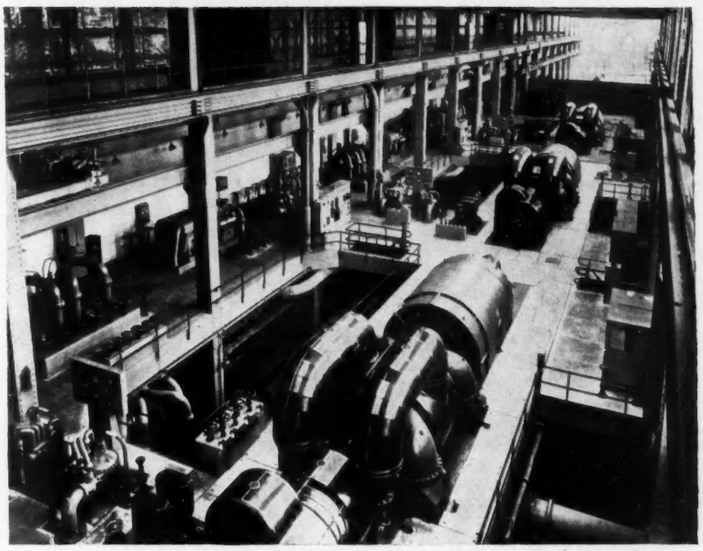


Fig. 3 The turbine room, showing three of the 30-MW turbo-alternators with the feed pump bay in background.

Conveyor Company, Limited, and John Thompson Industrial Constructions, Limited, Wolverhampton.

TURBO-ALTERNATOR DESIGN

The generating plant will eventually comprise six 3,000 r.p.m. turbo-alternators, of which three are at present in use, as shown in Fig. 3. These machines, which were manufactured by C. A. Parsons and Company, Limited, Newcastle-on-Tyne, are of the two-stage type and are designed to operate with steam at a pressure of 600 lb. per square inch and a temperature of 850 deg. F. This steam will be supplied from the boilers through six interconnected receivers in the basement. Steam is being extracted at four stages for feed heating.

The alternators, to which the turbines are coupled, are designed for a maximum continuous net output of 30 MW at 11·8 kV and a power factor of 0·8. They have direct-connected exciters which, like the main machines, are cooled by two separate motor-driven fans.

Each turbine exhausts into twin shell condensers, which were manufactured by G. and J. Weir, Limited, Cathcart, Glasgow, S.4, and have a total cooling surface of 25,000 sq. ft. The cooling water is drawn from the estuary at the maximum rate of 28,000 gallons per minute by vertical spindle pumps, which were supplied by W. H. Allen, Sons and Company, Limited, Bedford, fixed and travelling band screens, manufactured by F. W. Brackett and Company, Limited, Colchester, being installed for the removal of seaweed and other debris. Chlorinating plant has been provided by Wallace and Tiernman, Limited, Power-road, London, W.4, to inject chlorine into the circulating water and thus to prevent the growth of mussels and slime in the tunnels, culverts and condenser tubes.

The condensate is dealt with in four stages of feed heaters, the range including one electrically-driven feed pump with an output of 330,000 lb. per hour against a head of 800 lb. per square inch for each turbine. In addition, there will be two spare electrically-driven pumps and two emergency steam-turbine-driven pumps, which will be arranged so that they can be started automatically. All these pumps also have an output of 330,000 lb. per hour and were manufactured by G. and J. Weir, Limited. Make-up water is obtained from the town's mains through Permutit softeners and three central triple-effect evaporators with a net output of 25,000 lb. per hour, which were built by Aiton and Company, Limited, Derby.

ELECTRICAL EQUIPMENT

Each alternator is solidly connected to a main transformer of Parsons manufacture, one of which steps the voltage up to 33 kV and the others to 132 kV. The 33-kV transformer is controlled by switchgear, which was supplied by Ferguson Pailin, Limited, Higher Openshaw, Manchester, and is installed in a switch house adjacent to the office block, while the 132-kV transformers are controlled by outdoor switchgear, manufactured by the British Thomson-Houston Company, Limited, Rugby. This equipment, which is illustrated in Fig. 4, is controlled from a room in the office block. The 33-kV switch house is connected to two 5-MVA transformers which step the voltage down to 3·3 kV. The station auxiliary board is supplied at this voltage, as are the unit auxiliary boards which are connected to the low tension sides of 2-MVA 11·8/3·3-kV transformers associated with each set. The motors driving the principal auxiliaries are also operated at the latter voltage. Further 500-kVA step-down transformers reduce the voltage to 415 volts, at which other auxiliary equipment is supplied. All these transformers were manufactured by the Brush Electrical Engineering Company, Limited, Loughborough.

The design and construction of the first part of the station were handled by the headquarters staff of the Central Electricity Authority under Mr. V. A. Pask, the chief engineer, in conjunction with the consulting engineers, Messrs. Preece, Cardew and Rider and Sir Alexander Gibb and Partners. The construction of the second part of the station is being supervised by Mr. A. C. Thirtle, controller of the Authority's South Western Division and his construction staff under Mr. J. Irlam.

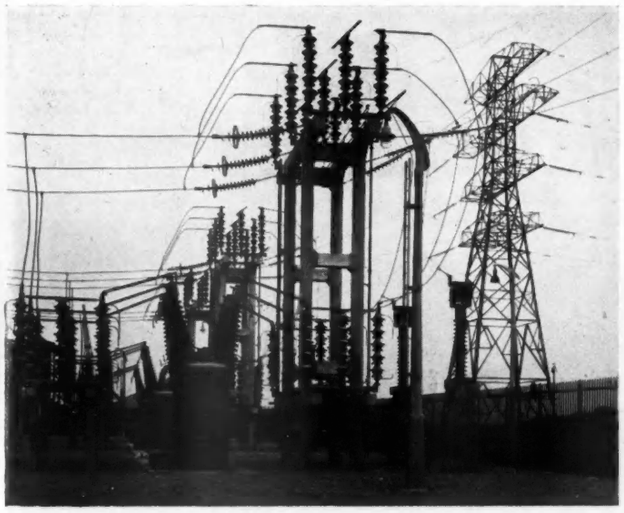


Fig. 4 132-kV outdoor switching station and line to Taunton.

★ ★ ★

CIVIL ENGINEERING RESEARCH

Open Days at R.R.L. and B.R.S.

Open days are to be held at the Road Research Laboratory and at the Building Research Station to exhibit the latest work being done at the two establishments. At the Road Research Laboratory, Harmondsworth, Middlesex, the open days have been arranged for Thursday and Friday, May 12 and 13, and both the Materials and Construction Division at Harmondsworth as well as the Road Safety Division at Langley will be giving practical demonstrations to illustrate the methods and processes evolved.

The open days at B.R.S., Garston, Hertfordshire, will be held on Monday and Tuesday, July 18 and 19. The work displayed will be limited to the engineering work of the station and will be of particular interest to civil and structural engineers. Applications to visit the establishments should be sent to the respective Directors of Research at the above addresses.

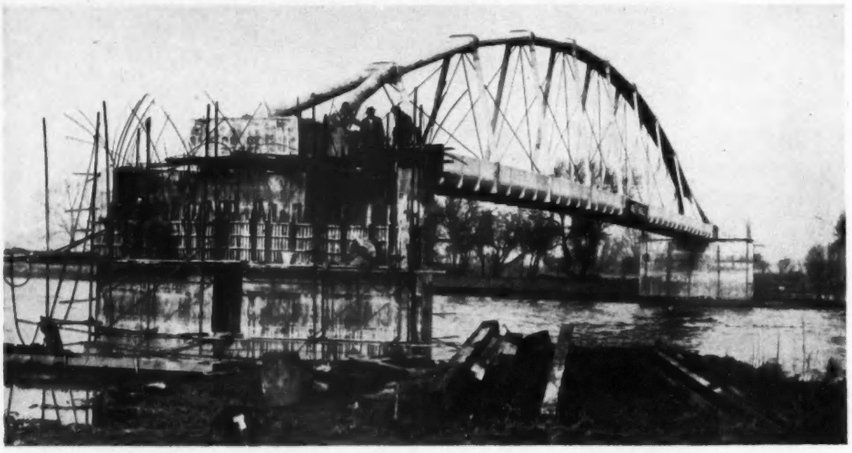


Fig. 1 The completed bridge in position on its abutments. Of prestressed pre-cast concrete members, the bridge, with a span of 250 ft., has a fine lightweight appearance.

OPEN-WEB BOWSTRING BRIDGE OF PRESTRESSED CONCRETE

A new prestressed concrete bridge has been built at Gunthorpe, near Nottingham, to carry two 21-in. water mains across the River Trent. The design of the bridge was largely determined by the fact that the busy traffic on the river had to have free passage during construction work and a bridge sufficiently light to be built on the bank and then launched across the river was needed. The open-web bowstring design in prestressed concrete shown in Fig. 1 above was selected as it fulfilled this requirement and also has the good appearance demanded by the pleasant site.

The bridge, shown in the cross-section, Fig. 2, has been designed with a single top boom, a bottom tie member consisting of two stiffening parapet girders with a light deck between, and triangular hangers joining these members. The abutments are vertical slabs of prestressed concrete, an approach ladder giving access to the walkway provided for inspection and repairs. The bridge has a single span of 250 ft. (the river is 234 ft. wide at this point) and an overall width of 10 ft.; the clear deck width is 7 ft. 9 in. The soffit of the deck is 20 ft. above the normal summer level of the river and the rise at mid-span between deck and boom is 28 ft.

The two 21-in. diameter water pipes are made in 25-ft. lengths and the design of the bridge was based on this dimension, the concrete hangers also being 25-ft. centres, coinciding with the joints in the pipes. Both the boom and girders are built up to 25-ft. bays between the hangers, each of which is prestressed with one 12-wire Freyssinet cable.

The slender arched boom section, shown in the cross-section, is a hollow rectangle with rounded sides and having 3-in. thick walls and a 3-in. thick central web; it is 3 ft. 4 in. wide and 1 ft. 4 in. deep overall. Its eight bays are each made up of four sections of pre-cast concrete, each approximately 6 ft. long, which were assembled and stressed together on the ground with one 12-wire Freyssinet cable. When completed, each bay was lifted into position and no further prestressing was applied to the boom as a whole. At both ends the boom divides into two solid arms, circular in section, which are cut away to fit over the pipes so allowing the latter free passage through the end blocks and into the abutment. The arms bear on Freyssinet hinges contained in the end blocks which are of heavily reinforced concrete cast *in situ* and prestressed in the transverse direction by fourteen 12-wire Freyssinet cables. Mild-steel bars crossing diagonally between the hangers have been used to provide bracing to resist buckling. The bars are protected against corrosion by zinc-rich paint.

The deck and girders together form the tie member, shown while under construction in Fig. 4. Like the boom, the prestressed-concrete girders are made up of four pre-cast sections, approximately 6 ft. long, within each bay; they are 3 ft. 8 in. deep and 3 in. thick, and have a top flange, projecting on the inner side only, containing a groove for prestressing cables. The web of each girder is straight for the greater part of its depth, so forming the parapet of the bridge and a protection for the pipes, but at the bottom the web is curved to join with the decking, as shown in the cross-section. The tie member is cross braced by pre-cast prestressed concrete ribs spanning between the girders at 25-ft. centres, and by simple struts at the joints between the 6-ft. sections within each bay. The former were stressed with a 12-wire and the latter with a 2-wire Freyssinet cable.

As the weight of the pipes is taken by the hangers, the deck itself has been designed to carry only such light and occasional loads as those of foot traffic or snow. It was constructed with "Shishkoff" hollow units of pre-cast concrete, each 11 in. wide, 4½ in. deep and about 6 ft. long, with walls and flanges ½ in. thick, spanning between the transverse braces. These units are made of a stiff mortar which is laid on to building paper and then folded round pairs of wedge mandrels; their manufacture was described in ENGINEERING in the article which began on page 220 of the issue of February 13, 1953 (vol. 175).

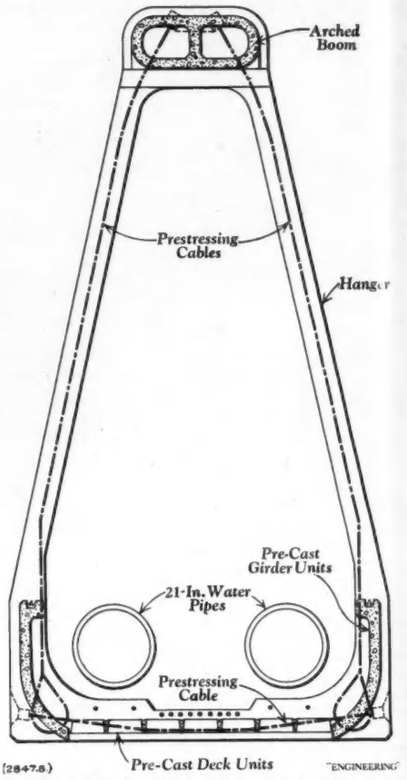


Fig. 2 Typical cross-section showing the prestressing cables in the hangers and tie member.

When the deck and girders were assembled they were prestressed together with fifteen 12-wire Freyssinet cables, three in the groove in the top flange of each girder and the other nine in the deck on the Shishkoff units. The anchorages for these cables are contained in the end blocks. A concrete screed was then laid over the units and the cables.

The permanent abutments are vertical slabs of prestressed concrete; one is fitted with Freyssinet hinges at the top and bottom to allow for expansion and rotation of the bridge, the other has a hinge at the top only to allow for rotation. The abutments are founded on reinforced concrete slabs themselves placed on Franki piles. A 5-in. thick prestressed concrete wall has been built round each abutment to

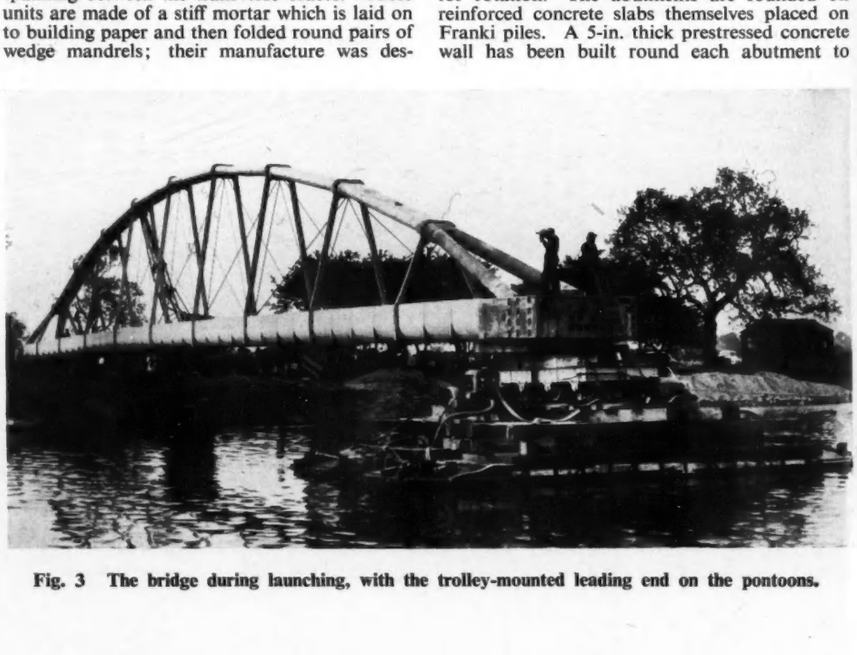


Fig. 3 The bridge during launching, with the trolley-mounted leading end on the pontoons.

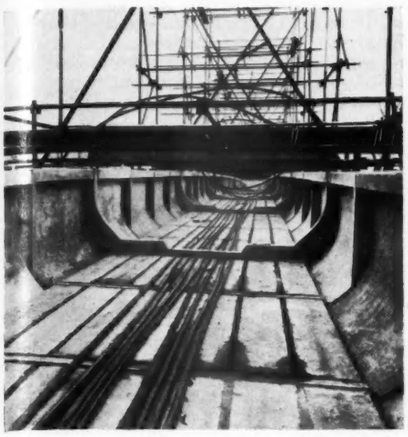


Fig. 4 The tie member under construction, showing the side-girders, deck and bracing pieces.

protect the vertical pipe connections between the pipes crossing the bridge and the cross-country subterranean mains.

ERECTION

The bridge was erected on the north bank of the river, and then launched across it and supported on temporary steel abutments while the permanent concrete abutments were being built. A length of railway line for the two launching trolleys was laid leading down to the river on the north bank. Between the trolleys, scaffolding was erected and the bridge built at a level high enough to allow the river to be opened to traffic immediately the bridge had been launched and secured to the abutments. The operation of launching the bridge across the river is illustrated in Fig. 3, opposite. The weight of the structure carried across the river was nearly 200 tons. These operations, carried out during the Whitsun weekend of 1954, required the temporary closing of the River Trent to traffic. After they were completed, the river was re-opened and the permanent abutments built.

CONCRETE DETAILS

The specification for the concrete for the bridge left the design of the mixes to the contractor but demanded a minimum strength of 6,000 lb. per square inch at 28 days, except for the end blocks where a minimum strength of 8,500 lb. per square inch at 28 days was required.

Ultrasonic tests were carried out on the concrete of the boom to determine the modulus of elasticity so as to verify the buckling calculations, and from these tests a mean value of the order of 5 million lb. per square inch was determined for the modulus. In testing the completed bridge, water from the river was pumped into the box formed by the end blocks, parapets and deck to 1·25 times the working load; the measured deflection was 1¼ in., from which figure the modulus was calculated to be somewhat smaller than that determined by ultrasonic methods. The difference was attributed to the "give" at the joints between the bays and the sections.

The bridge was built for the Water Department of the City of Nottingham, the City Engineer, Mr. R. M. Finch, O.B.E., M.I.C.E., undertaking supervision of the work for the Water Engineer, Mr. B. W. Davies, M.I.C.E., M.I.Mech.E., M.I.W.E. It was designed by the Pre-Stressed Concrete Company, Limited, 171 Victoria-street, London, S.W.1; Crowley, Russell and Company, Limited, 131 Victoria-street, London, S.W.1, were the main contractors; the Croft Granite Company, Limited, Croft, near Leicester, were sub-contractors for the pre-cast concrete; the Franki Compressed Pile Company, Limited, 39 Victoria-street, London, S.W.1, drove the piles. The ultrasonic testing was carried out by the Cement and Concrete Association.

LOADING, TRANSPORTING AND STACKING WITH THE SAME VEHICLE

SIDE-OPERATING FORK-LIFT TRUCK

The conventional fork-lift truck is best adapted to loads which are cubical or nearly so, and while it will lift and carry loads which overhang the forks at each side, its utility is limited with such loads when the space for manœuvring is restricted. The conventional truck, too, is by reason of its design unsuited for travelling long distances, especially on public highways. To overcome these difficulties and while still retaining the stacking and lifting features of the conventional fork-lift truck, a combined fork-lift truck and transport vehicle has been designed by Albert Irion Nachf., Stuttgart, Germany. It is distributed in the United Kingdom and the British Commonwealth by Materials Handling Equipment (Great Britain), Limited, 7 Chesterfield-gardens, London, W.1.

SIDE-LIFTING FORKS

The Irion fork-lift carrier is a four-wheeled vehicle with a flat deck or platform for carrying the load and a retractable mast-assembly for lifting, lowering and stacking it. An open-sided well in the deck accommodates the mast-assembly, which runs on rollers, the roller track being so located as to distribute the load equally between the two axles. The mast can be traversed outwards to pick up or deposit a load, and inwards to lower the load on to the deck for transport. A pair of double-acting hydraulic cylinders is used to extend and retract the mast and a third cylinder is used, with flat chains, for raising and lowering the forks in the usual manner.

To pick up a load the vehicle is driven alongside it and the forks are raised to the correct position. The mast-assembly is then extended from the well in the deck until the forks pass under the load, which can then be lifted. With the load on the fork the mast is retracted and the load is lowered to the deck for transport. To deposit the load it is lifted from the deck to the height required and the mast is extended. Finally, the forks are lowered and the mast is retracted as soon as the load is in the required position. The forks will operate at any height from ground level to a maximum height of 10 ft.

Two hydraulic jacks are built into the vehicle frame, one on each side of the mast well, to stabilise the vehicle when the mast is extended and a load is being lifted. These jacks, being on the same hydraulic circuit, are self-adjusting to an uneven ground surface. A red warning light is provided on the instrument panel in front of the driver to show when the jacks are lowered.

OPERATION IN CONFINED SPACES

The vehicle frame is of welded steel plate, with an overall length and width of 13 ft. 9 in. and 6 ft., respectively. There are four wheels, with 8·25-in. by 15-in. pneumatic tyres, the drive being from the rear axle through a differential of normal pattern. Car-type steering is provided on the front wheels, and in addition the front axle is mounted on a central pivot so that it can align itself with uneven ground. Hydraulic brakes are provided on all four wheels, and a parking brake operates on the rear wheels only. Since the vehicle can pick up its load, transport it and set it down in one straight line, it can operate in a gangway very little wider than the 6-ft. overall width of the frame. The turning circle is 9 ft. inside diameter, and the overall height, with the mast lowered, is 8 ft.

Control of the vehicle and of the lifting gear is from a driver's seat on the near side at the front, the travelling controls comprising a steering wheel, clutch pedal, foot and hand brakes, accelerator and gear lever, all mounted in the same way as on an orthodox road vehicle. Jacks, mast and forks are controlled by three hand-levers at the driver's right hand, the levers being clearly marked with the functions they perform. A neutral or "stop" position is provided for each lever to hold the jacks, mast or forks at any point in their travel. The driver's seat, which can be fitted with a Perspex cover for weather protection, is in an elevated position, giving a clear view of the load at all times, and of the road to the front, rear and sides. A tubular steel guard rail is provided to protect the driver from the load if it should swing or move accidentally.

DIESEL DRIVE

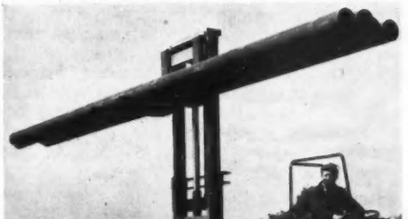
The power unit is a Mercedes-Benz four-cylinder Diesel engine of 75 mm. bore and 100 mm. stroke, developing 30 brake horsepower at 2,500 r.p.m. The engine is mounted in the frame beneath the rear portion of the deck, which can be lifted off to give access for servicing. A 130-watt, 12-volt dynamo provides current for the electric starter motor, glow-plugs and road lights, and a battery of 98 ampere-hours capacity is fitted under the deck. Fuel oil is carried in a 7·7-gallon tank accessible through a hinged cover in the rear deck. The engine is coupled through a single-plate dry clutch to a gearbox giving five forward speeds and one reverse, the coupling passing over the back axle to the gearbox and thence back to the differential. The gearbox gives road speeds of 2·58 m.p.h. in first gear, 4·4 m.p.h. in second, 7·16 in third, 11·87 in fourth and 15·5 in fifth. In reverse gear the speed is 2·5 m.p.h.

HYDRAULIC EQUIPMENT

Hydraulic power is supplied by a Plessey high-pressure gear pump coupled directly to the

The Irion fork-lift truck is shown picking up a load of timber, which it will traverse and then lower on to its deck for transport direct to the saw mill. The truck is further illustrated on the next page.

When the mast of the Irion fork-lift truck is retracted and the forks lowered, the load is deposited on the deck for transport.



In this view the stabilising jacks are shown at ground level and the mast is fully extended. For lifting loads such as tubes, the jacks are used to lift the side of the vehicle slightly, so that the load rolls to the back of the forks.

gearbox. It operates at a maximum pressure of 2,488 lb. per square inch, the supply rate being 6·6 gallons per minute. The pump draws its oil from a reservoir of 7·7 gallons capacity mounted beneath the rear deck, and feeds the stabilising jacks, fork-lifting cylinder and mast cylinders through the control valves at the driving position. A safety valve built into the oil circuit opens at 2,275 lb. per square inch to prevent overloading of the cylinders. The pump has sufficient power to raise the maximum load of 6,600 lb. at 20 in. load centres (that is, with the centre of gravity of the load 20 in. from the heel of the forks) at 50 ft. per minute. The lowering speed is the same.

The truck is complete with head, side and rear lights, electric horn and flashing direction indicators, and complies in every way with the requirements for use on a public highway. In its standard form it will handle loads of any kind which have no tendency to roll, such as steel sections, timber, sheet metals, cases and crates up to a length of 25 ft. or more. For loads such as tubes, pit props or other cylindrical objects, detachable steel stanchions can be supplied for fitting to the deck side. No special adaptation of the lifting forks is needed for loads of this nature; it is only necessary to extend the stabilising jacks fully, to lift the side of the vehicle slightly and so to tilt the mast and forks backwards. Cylindrical objects then roll to the back of the forks and can be lifted and lowered without difficulty.

The first Irion truck of the type illustrated has been delivered to the timber yard of the A.S.L. Trading Company (Coventry), Limited, where it was recently demonstrated. The previous method of unloading timber from road vehicles was by hand, a load of 4 standards taking 2½ hours and requiring the labour of 4 men. The same work is now done by the Irion truck in 30 minutes. Similar economies in time and labour have been recorded when loading road vehicles. Three lorries, for example, were loaded with a total of 10½ standards of timber in 55 minutes.

* * *

DISTRIBUTION OF AIR FOR VENTILATION

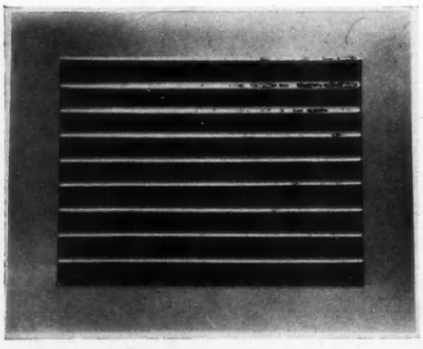
Control in Two Planes

The distribution of air in an air-conditioned or ventilated space is governed partly by the design of grille, and a recent advance in design was made by the introduction of the Deflecto Grille. This is manufactured by Richard Crittall and Company, Limited, 151 Great Portland-street, London, W.1, and permitted face velocities up to 2,000 ft. per minute in marine use, compared with a maximum velocity of about 500 ft. per minute when using the orthodox stamped grating. The high outlet velocities were made possible by the aerofoil design and the efficiently spaced grille blades, all of them individually adjustable.

Richard Crittall and Company, Limited, now announce the addition of the unit shown in the accompanying illustration to their range of ventilation fittings. Known as the type "D" Deflecto Grille, it is similar in design to the standard model, but instead of having two sets of individually adjustable blades, the vertical rear blades only are arranged thus, whilst the horizontal front blades are linked for collective adjustment, remaining parallel to each other through the full angle of deflection.

Length of throw, and zone of movement in the horizontal plane are thus controlled by the individually adjustable rear blades, and directional movement in the vertical plane is controlled by the front interlinked blades. Furthermore, effective distribution of the air is obtained with both cooling and warming systems, as the front blades can be deflected upwards or downwards. It will be observed that appearance of the unit has been improved by the use of smaller front blades set closer together, and a narrower flange.

The type "D" Deflecto Grille is available over a wide range of sizes and may be supplied, as the standard model, with or without the opposed blade damper. The latter unit, designed for air-volume control from complete shut-off to full output, embodies an equal number of damper blades arranged for opposed movement, so ensuring that the design features of the Deflecto Grille, even air distribution and direction, are maintained. The type "D" Deflecto Grille is, intended for air supply. There is, however, a matching grille available for extract points. It follows the same principles of design, but with the vertical rear blades omitted.



Face view of the type "D" Deflecto Grille, showing the interlinked front blades; behind them are the independently adjustable vertical blades.

* * *

LAUNCHES AND TRIAL TRIPS

H.M.S. "SCARBOROUGH."—Whitby class anti-submarine frigate, built by Vickers-Armstrongs Ltd., Walker-on-Tyne, for the Admiralty, London, S.W.1. Length 370 ft. overall; and beam 41 ft. Designed primarily for the location of the most modern types of submarines, and accordingly fitted with under-water detection equipment and anti-submarine weapons of post-war development. Armament comprises two 4·5-in. guns and two smaller guns. Propelled by geared steam turbines of high power. Launch, April 4.

S.S. "SIRIUS."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for the Sociedad Transoceanica Canopus S.A., Panama. Main dimensions: 560 ft. between perpendiculars by 80 ft. by 42 ft. 3 in.; deadweight capacity, about 24,900 tons on a summer draught of 32 ft. 4 in.; oil-tank capacity, about 23,550 tons. Double-reduction geared steam turbines, developing 7,300 s.h.p. at 100 r.p.m., in service, constructed by Richardsons, Westgarth & Co., Ltd., Wallsend-on-Tyne. Steam supplied by two Foster Wheeler oil-burning boilers. Speed, 14¼ knots. Trial trip, April 4.

M.S. "LUFIRA."—Single-screw cargo vessel, with accommodation for twelve first-class passengers, built by the Nakskov Shipyard, Ltd., Nakskov, Denmark, for the Cie. Maritime Belge, Antwerp, Belgium. Main dimensions: 446 ft. 10 in. by 61 ft. 2 in. by 39 ft. 3 in.; gross tonnage, 6,540. Cockerill-Burmeister and Wain six-cylinder turbo-charged oil engine, developing 7,800 b.h.p. Service speed, 16 knots. Trial trip, April 4.

M.S. "CAPETAN PSARROS."—Single-screw cargo vessel, built and engined by Swan, Hunter, and Wigham Richardson, Ltd., Newcastle-upon-Tyne, for the Tramp Chartering Corporation, Panama. Main dimensions: 450 ft. between perpendiculars by 62 ft. by 40 ft. 4 in. to shelter deck; deadweight capacity 13,320 tons on a draught of 30 ft. 7½ in. Swan Hunter-Doxford five-cylinder oil engine, arranged for burning boiler fuel and developing 5,500 b.h.p. at 115 r.p.m. in service. Speed on trial exceeded 15½ knots. Trial trip, April 5.

M.S. "STEYNING."—Single-screw collier, built by Austin and Pickersgill Ltd., Sunderland, for Stephenson Clarke, Ltd., London, E.C.3. Main dimensions: 231 ft. by 38 ft. 2 in. by 16 ft. 6 in.; deadweight capacity, about 2,040 tons on a mean summer draught of 15 ft. 9½ in. Clark-Sulzer eight-cylinder single-acting two-stroke trunk-piston oil engine, constructed and installed by George Clark (1938) Ltd., Sunderland. Speed on trial, 11¼ knots. Trial trip, April 6.

M.S. "ST. HILDA."—Single-screw trawler, built by Richard Dunston, Ltd., Hessle, Yorkshire, for the Friarage Steam Fishing Co., Ltd., Hartlepool. Main dimensions: 100 ft. by 22 ft. by 10 ft. 8 in.; fishroom capacity, 5,450 cub. ft. Oil engine developing about 400 b.h.p.; constructed by Crossley Brothers, Ltd., Openshaw, Manchester. Launch, April 6.

M.S. "HERMES."—Single-screw oil tanker, built by the Blythswood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for Bruusgaard, Kiosterud & Co., Drammen, Norway. Main dimensions: 510 ft. between perpendiculars by 68 ft. by 38 ft.; deadweight capacity, about 16,400 tons. Rowan-Doxford five-cylinder two-stroke opposed-piston heavy-oil engine, developing about 6,200 b.h.p., constructed by David Rowan & Co., Ltd., Glasgow. Launch, April 7.

M.S. "PHRYGIA."—Single-screw cargo vessel, built by William Hamilton & Co., Ltd., Port Glasgow, for the Mediterranean service of the Cunard Steam Ship Co., Ltd., Liverpool. Main dimensions: 348 ft. 3 in. (length) by 49 ft. 6 in. (breadth); gross tonnage, 3,533; deadweight capacity, 4,250 tons on a draught of 23 ft. 4 in. Rowan-Doxford four-cylinder opposed-piston oil engine developing 3,500 b.h.p., constructed by David Rowan & Co., Ltd., Glasgow. Speed, 14 knots. Trial trip, April 8.

TWIN-JIB BREAKDOWN VEHICLE

Designed for Oilfield Operation

Breakdown vehicles with powerful winching capacity have been designed and made by M. O. Harper, Limited, 19 Commercial-road, Guildford, for the Shell Petroleum Company, Limited, and are on their way to the Seria oilfield, British Borneo. The basic vehicles are six-wheeled six-wheel drive Scammell "Constructors" fitted, as is usual on oilfield trucks, with Darlington Model 70 winches behind the cabs. The new equipment consists of a power-driven crane with twin jibs and a specially designed all-steel body. The twin jibs and one jack-leg can be seen in the accompanying illustration.

Power for the crane, which is taken from a power take-off on the truck gearbox, drives two clutch-operated reversing gearboxes each of which is connected to a 10,000-lb. winch. The reversing boxes and the winches are built into the crane structure, one winch for each jib, and each box incorporating a double multiplate clutch connected to an operating lever on either side of the vehicle. It is thus possible to operate either one or both jibs simultaneously, from either side of the vehicle. Although the basic vehicle has already been in use with similar heavy winches and oilfield bodies, carrying up to 25-ton loads, these new machines, with their very powerful winching capacity, will be particularly suited to certain operational work in the oilfields such as laying pipelines, erecting drilling rigs, and for breakdown recovery in jungle conditions.

The foot of each jib is carried on a universal pivot so that it can be swung through an arc of approximately 135 deg. from the centre rear of the truck. The luffing action of each jib is controlled by single hand-operated winches built into the crane structure. For heavier loads, the jibs can be anchored together over the centre rear of the truck, in which case only one winch is used and the rope led round a switch block with its free end hooked on an attachment provided at the head of the other jib. To promote stability when lifting at the sides of the truck, telescopic jack-legs are provided. These are universally pivoted at their upper ends where they are attached to the crane structure.

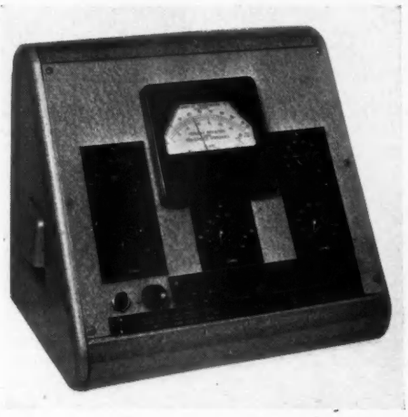
The specially designed all-steel welded body is fitted with a steel bumping plate at the rear and a tool box at each side. Its under-frame is fitted with heavy-duty sheaves and rollers, which guide the rope from the truck winch under the floor and out at the rear end through an aperture in the bumping plate. Further sheaves are mounted on the chassis frame so that this rope can be taken along its side and out at the front of the truck for front-end pulls and self-recovery work. For this purpose the heavy tubular bumper is fitted with a robust guide roller assembly for the passage of the rope.

Twin jibs and telescopic jack-legs to increase stability are features of a breakdown vehicle designed for use in the Seria oilfield of British Borneo.

THERMOMETER AND LIMIT BRIDGE

Direct-Reading Instrument for Test or Production Work

The Clare Instrument Company, 8 South-street, West Worthing, Sussex, have recently introduced a direct-reading bridge instrument which can be used either for measuring temperatures or as a limit-bridge for measuring resistances in production work. It is based on the conventional Wheatstone bridge network, but the meter is used to read the unbalance component, and not to indicate the null point. When used as a limit bridge, the built-in resistance is set to the nominal value and the lower scale then reads in percentage deviation; when used as a thermometer, it is first balanced at normal temperature, after which the temperature rise



Based on the Wheatstone bridge principle, this instrument can be used to measure resistance variation or temperature rise with an accuracy of 0·2 per cent.

can be read from the upper scale, which is calculated from the resistance change of a copper conductor. The zero of the valve-voltmeter can be monitored at any time by an additional pair of ratio arms.

The instrument is suitable for measuring resistances from 5 ohms to 1 megohm; the addition of a 10 to 1 mutiplier allows this range to be extended to measure from 0·5 ohms to 10 megohms. The accuracy is dependent on the quality of the standard resistors, which may be within either 0·1 per cent. or 0·5 per cent., giving overall accuracies at the balance point of within 0·2 per cent. or 1·0 per cent. respectively. The thermometer bridge is usually scaled for a rise of 50 deg. C. These bridges are built with scales to suit particular requirements.

DRILLING TO PRE-DETERMINED DEPTHS

Setting Gauge

The B.S.A. adjustable-length drill holder, made by B.S.A. Tools Limited, Mackadown-lane, Kitts Green, Birmingham, 33, is designed for drills, reamers or other tools with a standard Morse-taper shank, and can be used in any machine with a Morse-taper spindle. It consists of a main body, a knurled locking ring and a combined bush and stop-nut through which the drill projects. The lower end of the body is threaded to receive the bush, which can be screwed up or down and locked in position to leave more or less of the drill projecting as required. Tommy-bar holes are provided in the bush and locking ring for final locking after hand-adjustment.

The B.S.A. tool holder takes standard Morse-taper drills and other tools and enables holes to be drilled to a predetermined depth in any machine with a Morse-taper spindle.

In operation the drill is inserted in the holder and the bush is then screwed up the body until the distance between the drill point and the lower face of the bush equals the required depth of the hole to be drilled. A setting gauge, consisting of a block on which the drill point is placed and an adjustable rod which makes contact with the lower face of the bush, is supplied with the holder. This gauge enables setting to be done quickly and accurately, and also facilitates re-setting after drill-point grinding. The holder body, bush and stop-nut and locking ring are normally threaded left-hand to prevent over-drilling if the operator should fail to lock the bush after adjusting it. In such circumstances the bush would tend to work down the body when used on a machine with normal right-hand rotation, and so prevent drilling to too great a depth.

The maximum depth of hole which can be drilled when using the holder depends on the length of the drill, as the bush can be screwed up the body sufficiently to allow the whole of the normal drilling length of the drill to be used. The minimum depth of hole is according to the length of the bush, which is made to suit a user's requirements. The holder is made at present in the following sizes: No. 2 Morse taper outside (for the machine spindle) and No. 1 Morse taper inside (for the drill); No. 2 taper outside and inside; and No. 3 taper outside and inside.

★ ★ ★

PAINT FOR CONCRETE FLOORS

Coloured rubber paint for the protection and decoration of concrete floors has recently been introduced by Allweather Paints, Limited, 36 Great Queen-street, London, W.C.2. The paint, known as Pitan concrete floor paint, is quick-drying and alkali-resistant; it can therefore be used on 14-day old concrete floors without fear of breakdown, and when existing floors are painted they are out of use only for a short time. The paint covers 30 to 50 square yards per gallon, and is available in several shades. The manufacturers recommend the application of one coat in the case of dark shades and two or more coats in the case of light shades.

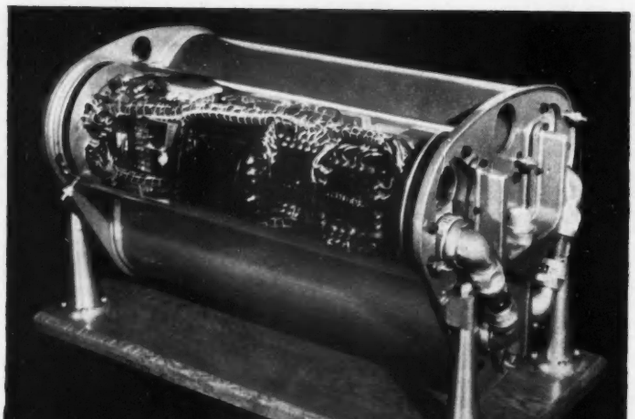


Fig. 1 Electronic apparatus for guiding missiles. General Electric Co., Ltd.

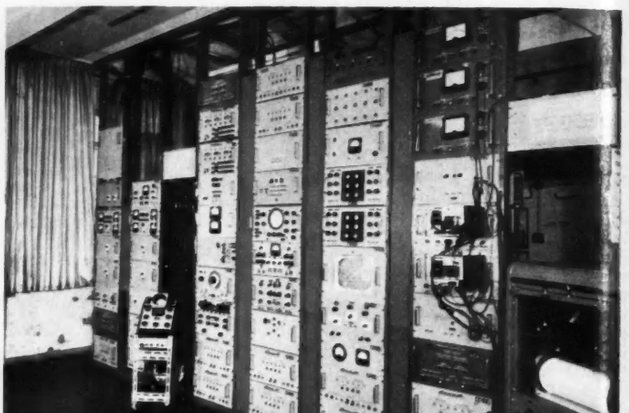


Fig. 2 Equipment for evaluating the performance of guided missile apparatus. General Electric Co., Ltd.

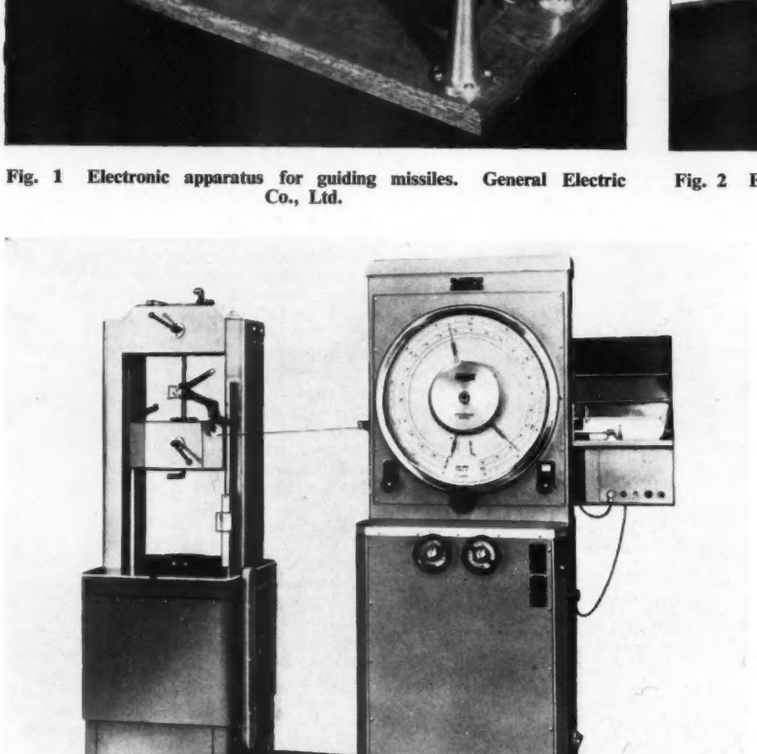


Fig. 3 Hydraulically-operated universal testing machine with a capacity of 60,000 lb. W. & T. Avery, Ltd.

Fig. 4 Tensile testing machine for wire, plastics, rubber, textiles and cement. W. & T. Avery, Ltd.

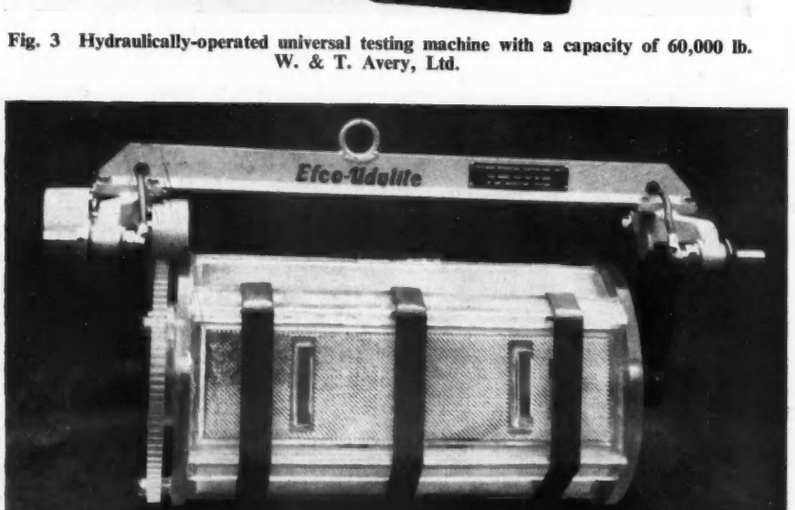


Fig. 5 Perspex plating barrels can be taken through alkalis and acids without transferring the contents. Electro-Chemical Engineering Co., Ltd.

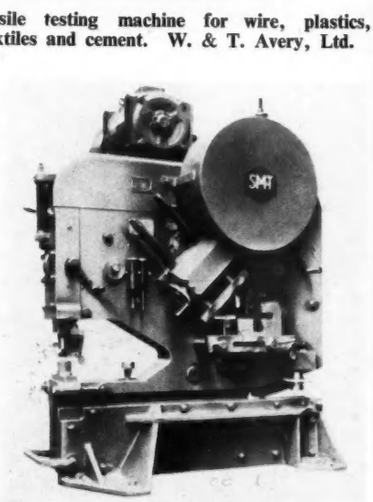


Fig. 6 Punching, shearing and cropping machine. Scottish Machine Tool Corporation.

BRITISH INDUSTRIES FAIR

ENGINEERING EXHIBITS AT CASTLE BROMWICH

This year's British Industries Fair is to be held at Castle Bromwich, Birmingham, and Olympia, London, from May 2 to 13. For the first time in its 40 years' history there is to be an official opening ceremony. This will be performed by Admiral the Earl Mountbatten of Burma at Olympia on May 2—one of his first engagements after taking up his appointment as First Sea Lord. The Fair this year is being run wholly as a commercial undertaking. The London section is being managed by a company, British Industries Fair Limited, which has taken over from the Board of Trade. The Birmingham section will again be managed by the Chamber of Commerce of that city. The chairman of the new company is Sir Ernest Goodale, C.B.E., M.C.

Various steps have been taken to improve the popularity of the Fair. At Olympia a new basic charge for stand construction has reduced the cost of smaller stands by something like one third. Cuts have also been made in the charges for electrical fittings and installations. Moreover, the whole London section is to be under one roof at Olympia, which will bring every stand on to a "busy street." Administration costs will also be reduced as the times allowed for erection and dismantling have been cut. To increase popular appeal, the general public will be welcomed every day after 2 p.m. and all day on Saturday, May 7. The Fair is open from 9.30 a.m. to 6 p.m. both at Castle Bromwich and Olympia, but on May 6 and 11 the London section will remain open till 9 p.m. The Fair will not be open on Sunday.

In the series of articles of which this is the first, we describe some of the more important engineering exhibits.

SELF-CONTAINED BOILERS

The main items on the stand of G.W.B. Furnaces, Limited, Dibdale Works, Dudley, Worcestershire, will be two of their "Powermaster" boilers, which are designed for firing on either gas or oil fuel. They are available for pressures up to 250 lb. per square inch, and can be fitted with a burner which operates on one particular fuel or with a burner enabling them to be changed from one fuel to another rapidly when required. No foundations are needed, the boilers being self-contained and ready to be used on any level concrete floor. The two boilers exhibited will represent the extremes of the available range, being designed for outputs of 17,250 lb. and 517 lb. of steam per hour, respectively. These boilers were described in ENGINEERING, vol. 177, pages 418 and 441. (See also vol. 178, page 5.)

GUIDED MISSILES

A feature of the General Electric Company's stand at Castle Bromwich this year will be the use of models to illustrate the firm's activities in the fields of power generation and utilisation, electronics and communications, and lighting and domestic equipment. These models will include one of a 120-MW three-cylinder reheat turbo-alternator and another of the 1,500-volt direct-current motor-coach which has been supplied to the Estoril Railway in Portugal. On this section of the stand there will also be three illuminated and coloured transparencies, one of which will show the 375-MW Orlando station at Johannesburg.

Special interest will doubtless be shown in two pieces of equipment which have been developed by the company for the guidance of missiles. Although details of these cannot be published, Fig. 1 shows a typical example of current development in this field. In addition, one illuminated photographic transparency will show some electronic apparatus for the simulation of a guided missile system, which enables the complete airborne equipment to be developed and evaluated in the laboratory. This equipment is illustrated in Fig. 2. The electronic section of the stand will display a number of examples of transistors, magnetrons, sub-miniature valves and other components, as well as a map illustrating the company's contribution to the Eurovision scheme, including the 125-mile radio link which spans the Alps.

STREET LIGHTING EQUIPMENT

The lighting equipment shown by the company will include a new aero screened (i.e., screened to avoid interfering with aircraft flights) lantern for main-road lighting, especially those in the vicinity of airfields. This lantern has a medium-angle beam distribution, the peak intensity occurring at 75 deg. to the vertical, while at 80 deg. it is two-thirds of the maximum value. The cut-off type of construction produces a rapid decline above 80 deg., falling to a negligible figure at the horizontal. The lantern will contain the firm's new horizontal-burning colour-corrected 400-watt mercury fluorescent lamp. This has a higher efficiency than a mercury lamp of similar rating and is, moreover, coated with a new germanium-based phosphor on the inner surface of its glass, thus increasing the proportion of red in the spectrum of the light emitted.

The optical system consists of two fluted reflectors inside the canopy, one on each side of the lamp. Each reflector is curved both horizontally and vertically in order to obtain the necessary intensity from a relatively small aperture. The enclosing glass bowl is fixed to the canopy by a hinged retaining ring and is so designed that no part of it can be seen above the angle of complete cut-off, that is, 60 deg. above the horizontal.

WEIGHING AND TESTING MACHINES

Among the industrial weighing equipment to be exhibited by W. and T. Avery, Limited, Soho Foundry, Birmingham, 40, is a bench scale with an automatic tare device. It will be seen in use for weighing oil into drums, but is equally suitable for other liquids and for solids in powder form. Operation is automatic after an empty drum has been placed on the platform and a push-button has been pressed to start the cycle. The tare weight of the drum is counterbalanced by the machine, and the oil feed is started. At a predetermined point the main feed cuts off and a dribble feed commences. Finally, the dribble feed stops when correct weight is reached, and the filled drum is ready for removal. Also in the industrial weighing machine group is a platform scale with a hand-operated weight-ticket printing mechanism. Tickets are inserted in a slot at the side of the weight-indicating dial, and the weight as shown on the dial is printed on operation of the mechanism. This scale also incorporates a rapid tare device which enables the weight of containers to be counterbalanced by turning a knob.

The range of testing machines to be shown includes two new models of the universal type and one for tensile testing only. The universal machines are similar in the range of tests they will carry out, but are of different capacities. Both are suitable for tensile, compression, transverse, shear and hardness testing, and can be fitted with autographic recorders and load-maintaining equipment. Full dial indication of load is provided in each case. The smaller machine is of 12,000 lb. capacity and is also available with a capacity of 5,000 lb. The larger machine has a capacity of 60,000 lb. It is hydraulically operated and is shown in Fig. 3. The tensile testing machine has been designed for dealing with a wide range of materials up to a maximum load of 2,500 lb. Loads are indicated on a large circular chart. The machine is equipped for testing metals in the form of wire and strip, as well as plastics, rubber, textiles and cement, and is shown in Fig. 4. It has a height of 6 ft. 7 in. and can be mounted without special foundations. The pump unit is contained in the cabinet.

CLEANING AND DEGREASING

The main exhibit on the stand of the Electro-Chemical Engineering Company, Limited, Queen's-road, Weybridge, Surrey, will consist of a working demonstration of the Efco process of di-phase metal cleaning and de-greasing. In this process use is made of two immiscible liquid phases of differing densities. These are brought into contact with the work simultaneously either by dipping the work through an upper solvent layer into a lower emulsion phase or by spraying it with streams of both phases together. The solvent phase consists of hydrocarbons plus free fatty acids which dissolve lubricating and cutting oils; and the emulsion phase of an emulsion soluble in water, combined with soaps, wetting agents and dispersants. This phase dissolves water-soluble compounds, such as brazing residues and the inorganic salts deposited by finger prints. It is claimed for the process that it is much cheaper than trichlorethylene vapour de-greasing besides being non-toxic and providing some protection against rust.

PERSPEX PLATING BARRELS

In addition the firm will be exhibiting examples of their Perspex plating barrels, one of which is illustrated in Fig. 5. These are of similar design to the barrels made from hard rubber and laminated plastics material, but, except for the bearings and hangers which are protected with suitable insulating material, they are of Perspex throughout. They are lighter than the other types of barrel and their mechanical strength is greater, while they are specially treated before manufacture to prevent cracking and distortion. Barrels of this material are being used to contain most normal electroplating solutions, including stannates, the temperature of which does not exceed 180 deg. F. They can be taken through hot alkali cleaner, water rinse, acid dip and acid or alkali plating processes without intermediate transfers of work being necessary, provided there is not an excessive amount of grease on the articles. Quick-release spring clamps and hand-grips are provided for easy unloading. The barrel measures 30 in. by 14 in. internally and can accommodate loads up to 100 lb. The standard perforations are $\frac{1}{8}$ in. in diameter giving 25 per cent. open area.

STEEL FABRICATION EQUIPMENT

The Scottish Machine Tool Corporation, Limited, 124 St. Vincent-street, Glasgow, C.2, will be showing three machines for the steel fabrication industry: a combined punching machine cropper and shear, a hydraulic press brake and a 150-ton power press.

The combined machine is built on a frame which is mainly of fabricated steel, with the driving motor mounted on the top. It is shown in Fig. 6. The drive is by V-belts to one of two heavy flywheels. One end of the machine is adapted for plate punching, and provision is made for lowering the punch to the plate by hand, when required for precision positioning of the plate. An interchangeable die-support is provided for punching channels, joists and other rolled sections. The shear is at the opposite end of the machine from the punch, and the main frame is formed with a slot enabling a plate of any length or width to be split by the shear blades. Above the shear the machine is arranged for cropping angles, T's, rounds and squares, and additional blades can be provided for dealing with joists, channels and bulb-angles.

The hydraulic press brake exerts a force of 100 tons, and is capable of bending mild steel plate $\frac{5}{8}$ in. thick by 10 ft. long to a right angle. The stroke of the slide is 9 in. The machine frame is of fabricated steel, with main and return hydraulic cylinders secured to it for actuating the slide. Hydraulic power is provided by an "Electraulic" pump mounted between the housings. Control is by a pedal-switch at the front of the machine.

The power press is capable of 15 blows per

minute, with a force of 150 tons near the bottom of the stroke. The bolster has a width of 72 in. and a depth, from front to back, of 26 in. It is matched by a slide face of the same dimensions. A vertical die-space of 31½ in. is available when the slide, which is adjustable over a distance of 8 in., is at the top of its adjustment. The press is driven by a motor of 15 h.p., a secondary motor of 4 h.p. being provided for slide-adjustment. Control is by push-buttons (run, inch and stop), through solenoid valves and an air-operated clutch. Bearings and guide-ways are lubricated by high-pressure oil from a built-in motor-driven pump.

OIL-FREE COMPRESSED AIR

Included in the range of air compressors and spraying equipment exhibited by Dawson, McDonald and Dawson, Limited, Ashbourne, Derbyshire, will be the "Compton" diaphragm compressor, which is designed for supplying compressed air completely free from all traces of lubricating oil. The compressor operates on the same principle as the diaphragm pump, and is particularly suitable for use in the food processing industries, in laboratories, or for certain types of paint spraying, where freedom from contamination is essential. The compressor (Fig. 7) can be belt-driven from a separate motor, as illustrated; similarly mounted and driven by an internal-combustion engine; or it can be spigot-mounted on an electric motor to form a single unit. In the direct-drive version only one bearing is provided on the compressor; half the load is carried by the motor bearing. For belt or chain drive, two bearings are provided for the compressor shaft.

The shaft carries an eccentric which is coupled by means of a connecting rod to the underside of a flexible diaphragm; this is deflected ¼ in. each way at each stroke. The diaphragm and the two circular components which form the compressing unit are attached to the top of the connecting rod by a single screw. The diaphragm is housed in a circular casing and held in a recess at its circumference by a valve-plate. This, in turn, is held by a finned surge chamber through which an air inlet tube projects. The inlet terminates at the top in a filter, and has a stainless-steel strip valve at the bottom. A similar valve is used in the valve-plate for delivery of compressed air to the surge chamber, where there is ample space for damping out the pulsations. A relief valve is fitted in the surge chamber to govern the maximum pressure, and a ¼-in. B.S.P. union is provided in the chamber for connecting the delivery pipe. With a 5¼-in. diameter diaphragm and a speed of 950 r.p.m. the compressor delivers 1·6 cub. ft. of free air per minute at 20 lb. per square inch. Pressures of up to 40 lb. per square inch are possible, and other sizes, with delivery rates up to 15 cub. ft. are available. The compressor will also function satisfactorily as a vacuum pump, drawing up to 18 in. of mercury.

PUMPING DRY POWDERS

The DM type Mono Pump, first exhibited some 18 months ago by Mono Pumps Limited, Mono House, 1, Sekforde-street, London, E.C.1, has now completed extensive field development trials, and is available in two sizes for handling loose dry powders which have no clogging, compacting or fusing tendencies. On view on the Mono Pumps stand will be the DM 12 unit (Fig. 8), capable of outputs up to 250 cub. ft. per hour at speeds up to 300 r.p.m. Powers of 2 to 5 h.p. are required, depending on the physical characteristics of the powder, the degree of fluidisation and on the nature of the piping system. The smaller sized model, the DM 10, provides outputs up to 100 cub. ft. per hour at speeds up to 250 r.p.m. Fluidisation of the powder is necessary to reduce friction in the pipeline. There is little existing information on the pumping of powder, but the Research Department of Mono Pumps Limited has now collected considerable data on the movement of powders through enclosed pipeline systems.

Applications of the Mono Pump to conveying cereals or cereal products are under joint development with Henry Simon Limited, Cheadle Heath, Stockport, who have sole marketing rights for the DM type pump for this class of duty. Applications involving the handling of any other dry material can be considered by Mono Pumps Limited, on the basis of physical examination and tests, so that the reaction of the material to pumping can be assessed.

Also on view on the Mono Pumps' stand will be their D and H pumps for handling free-flowing or viscous fluids, available in cast iron, ebonite-lined, stainless steel or gunmetal; and a new Snorer by-pass to protect the pumping element where pumps are used for dealing with a slow or intermittent feed of fluid, as in mining applications requiring that the pump should work continuously even though it may be taking more air than water. The pump illustrated in Fig. 9 is a new surgical suction unit for use in hospitals. The Mono Pump principle of a single rotating element without valves, gearing or lubricators, is particularly suitable for use in operating theatres or for dental use. The unit is constructed so that any material accidentally drawn into the pump will not damage the unit and will not cause loss of the normal vacuum (up to 28 in. Hg.).

POWER PRESSES

Three power presses have been chosen to represent the range made by Taylor and Challen, Limited, Derwent Works, Birmingham, 19.

For the manufacture of hot brass stampings there will be shown a machine of 200 tons capacity, with a stroke of 18 in. It is illustrated in Fig. 10. It is of the screw type, with a one-piece cast frame strengthened by shrunk-in tie-bars. The screw is of alloy steel, and runs in a phosphor-bronze nut screwed and keyed into the frame. The press is driven by a 15-h.p. motor through V-belts, and both the stroke and working pressure can be varied as required by a handwheel adjustment in the control gear. The design incorporates centralising gear and a brake which holds the flywheel in a neutral position midway between the driving discs when the press is not actually making a stroke, thus preventing unnecessary wear of the friction belt.

A 120-ton single-action press for drawing and raising is to be shown in action. It has a built-up frame with shrunk-in tie-bars, and bed size of 76 in. from right to left and 36 in. from front to back. The stroke is 8 in., and the slide, which is air-balanced, has safety gear to prevent it falling accidentally. Drive is from an 18-h.p. motor through a key-clutch with a one-stroke trip. The press is complete with an air-operated guard at the front and a fixed guard at the back.

An open-fronted inclinable press will be exhibited with a double-roll feed for strip material. The press is driven by a 3-h.p. motor through single gearing and has a speed of 50 strokes per minute. The feed mechanism is arranged for infinitely-variable travel up to 5½ in. Provision is made for automatically releasing the strip from the roll-feed when pilot punches are used in follow-on tools. The feed-rolls can also be released by a pedal when strip is to be inserted. The press is complete with coil-carrier and scrap-winder, and has a fixed guard which is coupled to the clutch mechanism to prevent the press from being started accidentally when the guard is raised for tool setting.

AUTOMATIC UNLOADING OF COMPONENTS FROM POWER PRESSES

An automatic component unloader, available in two different forms, and suitable for power presses with a stroke of over 6 in. and a working speed of up to 36 strokes per minute, is to be shown by J. P. Udal Limited, Court Road, Birmingham, 12. The two forms of unloader are similar, but one is designed for removing components positively ejected from the upper tool, while the other is for taking components from the lower die of the press. The unloader is mounted on the same basic structure as the Udal rising-screen automatic press guard, and when an operator is needed, as in multiple-tool set-ups where components have to be transferred from one station to another, an automatic press guard can be used in place of the unloader. Both forms of unloader are interchangeable.

Type "A" unloader, which can be set up in five minutes, consists of a parallel linkage mounted at the rear of the press and incorporating a tray which is automatically moved under the upper tool to receive the component as it is ejected. The tray is then withdrawn clear of the back of the press and tilted to allow the component to fall into a bin or other receptacle as required. Fig. 11 shows the tray withdrawn and tilted, and the component falling into the bin. The unloader is driven from the press slide, using the same mechanism as the automatic guard. Adjustment is provided in the arms of the linkage to allow for tools of different heights.

Type "B" unloader is also based on the parallel linkage, but incorporates a pair of gripper jaws, operated by compressed air, to lift the component from the die. This model is normally driven from the press crankshaft, but it can be provided with its own driving mechanism, controlled by the working cycle of the press. In operation it is similar to the type "A" unloader, the arms and gripper jaws moving inwards on the return stroke of the press, but in this case the gripper jaws actually lift the component from the die, and carry it out clear of the back of the press to a point where it is released and falls into a bin. The setting time of this model of the unloader is 20 minutes or less.

CONVEYOR FOR SMALL-RADIUS BENDS

For installation on difficult sites or where for any reason small-radius bends have to be negotiated, G. R. Turner, Limited, Langley Mill, Nottinghamshire, have designed the chain conveyor which they will be exhibiting at the B.I.F. The conveyor is applicable to many different types of work, and can be fitted with trays of steel or other material as required. It consists essentially of a chain in which the links are connected in two planes to provide flexibility. This is achieved by coupling the links with a vertical pivot at one end and a horizontal one at the other. Supporting wheels are mounted at the horizontal joints and guide wheels at the vertical joints. The chain carries a series of trays which are approximately rectangular in section, and overlap the joints by means of semi-cylindrical ends. Slats can be fitted instead of trays if required. The chain and trays are carried on a light framework of structural steel, with rolled steel angles forming the load-carrying and guide tracks. The conveyor is designed to be built from standardised components and can be dismantled and re-erected quickly. A different layout can be arranged with a minimum of structural alteration.

The conveyor exhibited has been built specially for this purpose. It has a capacity of 350 tons per hour, and is driven by two 45-h.p. motors in tandem. It is capable of negotiating a bend of 9 ft. radius to the centre of the conveyor in the horizontal plane, and 8 ft. radius in the vertical plane. The running speed is 200 ft. per minute. As shown in Fig. 12 it could have a length of up to 700 or 750 yards without a boost drive, provided that there was no vertical lift. For greater lengths, or to make the conveyor serve also as an elevator, boost drives could be incorporated according to requirements.

HAND TOOLS

The range of "Britool" wrenches and service equipment to be exhibited by Jenks Brothers, Limited, Bushbury, Wolverhampton, includes several new items. The mobile service kit which will be shown is designed for vehicle or plant maintenance. It contains socket, ring and open-ended spanners to fit bolts and nuts in Whitworth, B.S.F., American and Unified sizes from 0·152 in. to 2 in. across the flats.

The complete range of "Britool" torque wrenches, ranging from 5 in. lb. to 4,800 in. lb., will be exhibited for the first time, and another new product is the carbon steel open-jaw wrench which is intended as a lower-priced supplement to the firm's chrome-alloy wrench. It is available in English, American, unified and metric sizes.

(To be continued)

Fig. 7 Small diaphragm compressor giving oil-free air. Dawson, McDonald and Dawson, Ltd.

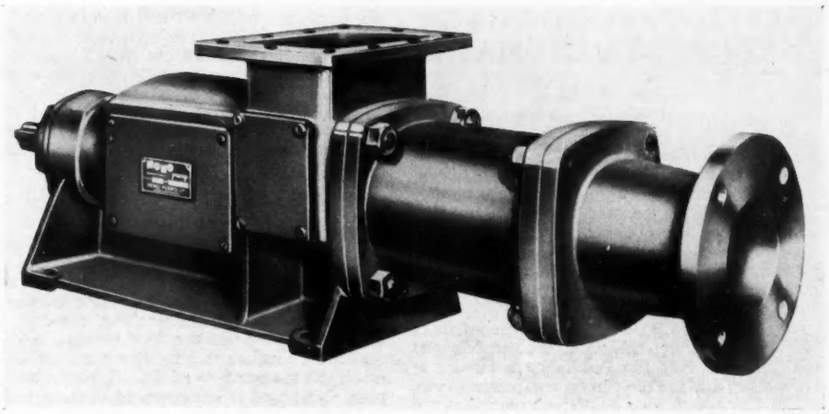


Fig. 8 Pump for handling dry powders, including cereals, with a maximum capacity of 250 cub. ft. per hour. Mono Pumps Ltd.

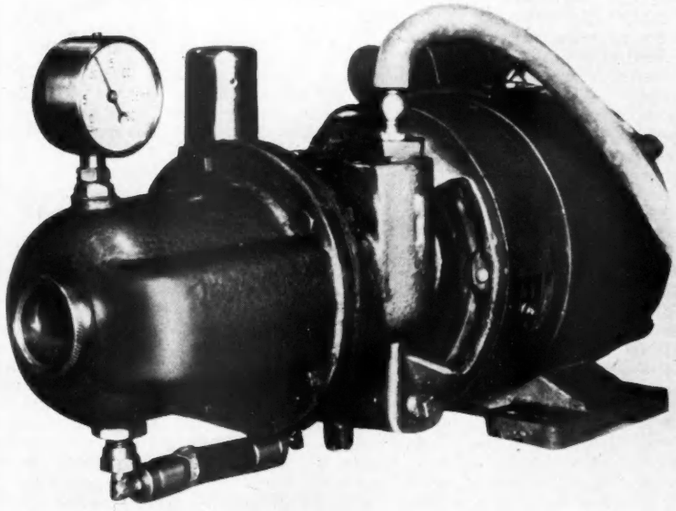


Fig. 9 Surgical suction pump for hospital and dental applications. Vacuum up to 28 in. Hg. Mono Pumps Ltd.

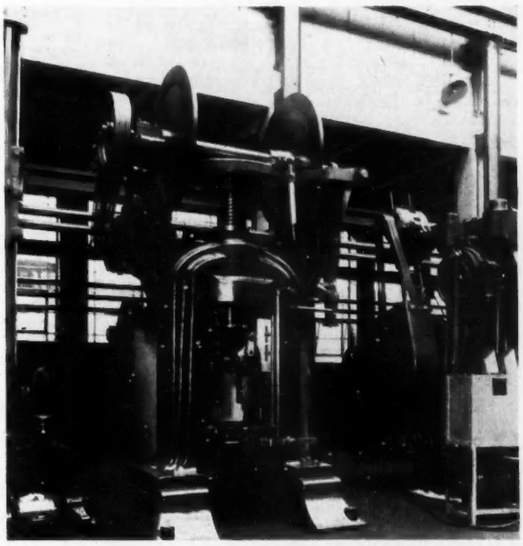


Fig. 10 Heavy-duty press for hot brass stampings; 200 tons capacity. Taylor and Challen Ltd.

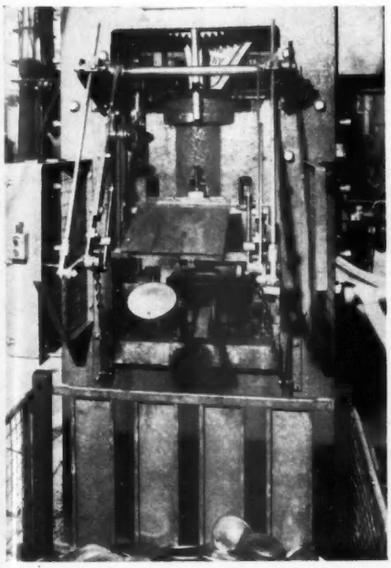


Fig. 11 Automatic unloader, worked from the press-slide, ejecting stamping. J. P. Udal Ltd.

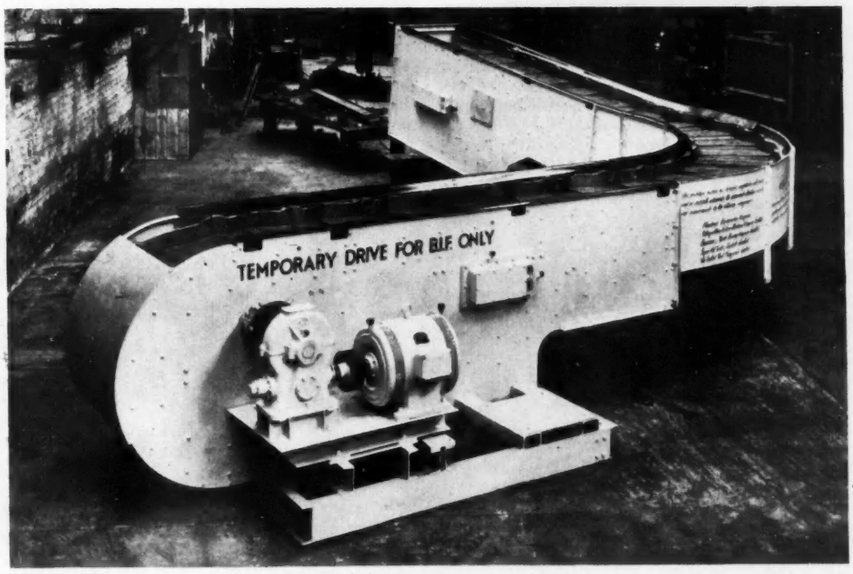


Fig. 12 Tray conveyor for operation with small radii in either the vertical or horizontal plane. Demonstration model. G. R. Turner Ltd.

SURFACE-HARDENING RENDERED AUTOMATIC

Development of Oxygen/Town-Gas Process

The chief problem in hardening metallic components to-day is to find methods of handling the components quickly, thus keeping the hardening machinery in constant use. Methods towards solving this problem, and also of reducing operating costs, are being developed by the firm of Paul Ferd. Peddinghaus, Gevelsberg, Westphalia, Germany; their agents in Great Britain are Surfard, Limited, Abbey House, 2 Victoria-street, London, S.W.1. At a recent conference on flame-hardening held in Essen the delegates were able to visit the Peddinghaus factory at Gevelsberg and see their latest equipment in use.

The flame-hardening equipment manufactured by Peddinghaus was described in ENGINEERING, vol. 173, page 268 (issue of February 29, 1952); the main features of the system are the use of oxygen/town-gas in conjunction with specially-designed burners, and the Milliscope automatic temperature-controlling instrument. The Milliscope is basically an optical pyrometer, the electrical output from which can be used to control the length of time components remain subjected to the flame. It is well suited to give fully-automatic control of flame-hardening machines, one of which is illustrated in Fig. 1.

The machine shown is the Model AU, and is being used in this case for hardening adjustable tappet heads. The heads are fed into the machine from the guide-way on the left, and are placed as shown on the bosses which are carried round by the main platform. The platform indexes round until the head is between the burners, which are clearly shown with a tappet head in position between them. The flame plays on the workpiece, which is made to rotate, until the Milliscope, which can be seen as a large cylindrical object at the bottom right corner of the illustration, indicates that the required temperature has been reached. An impulse from the Milliscope then causes the platform to index round so that the heated tappet head is under the quench, from where it is ejected down a chute.

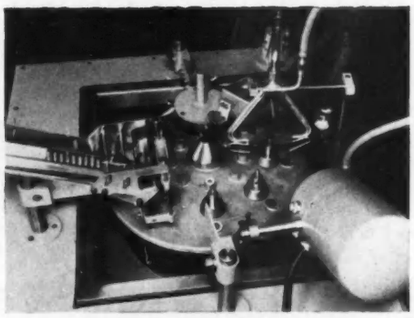


Fig. 1 The components hardened by this machine are adjustable tappet heads, which are fed into the machine, hardened, and ejected completely automatically.

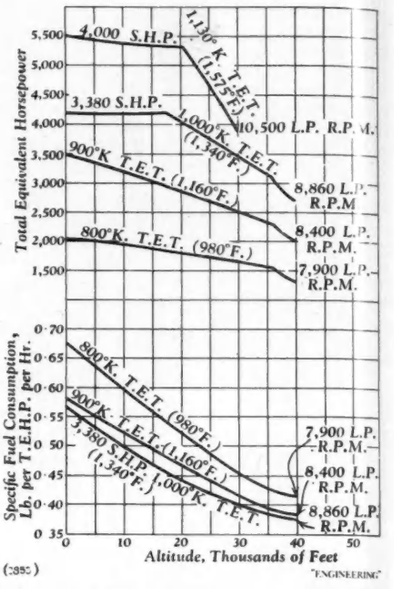
SPINNING METHOD OF HARDENING

Fig. 2 shows the spinning method of hardening, suitable for some carbon and alloy-steel gears having teeth of 6 D.P. and smaller. The gear is rotated between the burners until the required temperature is reached, and is then submerged into the appropriate quenching medium. In the illustration there are four burners, and the quenching medium is oil. Quenching naturally raises the temperature of the oil, and a cooling plant for the oil is incorporated in the machine, so that conditions of quench will be the same on all occasions. The Milliscope ensures that quenching takes place at the same temperature for each gearwheel of a batch; in this way there is no need to rely on a human operator to estimate the temperature of each gear, and long runs can be treated with precision. Flow-meters and pressure gauges are provided in a special unit, and the data from these in conjunction with the hardening temperature employed are recorded on a card, so that at any time the machine may quickly be reset to harden any type of component which may not have been handled for some time.

The machine illustrated in Fig. 3 is the UVW universal machine, being used to harden splines. In this case each spline is hardened individually and the workpiece is indexed round by hand from one spline to the next. The machine can also be used for spinning flame hardening. The workpiece is rotated mechanically about a horizontal axis, and the burners travel along at a rate which can be controlled by a variable-speed motor; the quench moves along on the same carriage as the burners.

FLAME-HARDENING CONFERENCE

Papers at the flame-hardening conference held at Essen on March 29 and 30 covered both technical and economic aspects. A number of contributions showed the advantages of using flame hardening in railway engineering; hardening the flanges of locomotive and wagon tyres; hardening and tempering railway point rails; hardening various components of steam locomotives, and the driving pinions of electric locomotives. Other papers described the application of flame hardening to metallurgical works, rolling-mill plant, and shafts of small electric motors. Papers of a more general nature dealt with the design of components to be flame-hardened, the economics of flame-hardening, hardenability tests, and tests on hardened components.



Power and fuel-consumption curves of the Bristol Aeroplane Company's new "constant-power" propeller turbine at an equivalent airspeed of 220 m.p.h.

TWO-SPOOL PROPELLER TURBINE

4,000-H.P. BE25 Maintains Power to 20,000 ft.

Preliminary details of the performance of the BE25 "constant power" propeller turbine under development for the next generation of Britannia air liners have been released by the Bristol Aeroplane Company, Limited, Filton, Bristol, and are given in the form of power and fuel-consumption curves in the accompanying illustration. The curves correspond to an equivalent airspeed of 220 m.p.h. under international-standard-atmosphere conditions, and make no allowance for intake loss or power take-off. It will be seen that, under these conditions, a constant maximum shaft horse-power of 4,000 s.h.p. is available from sea-level up to 20,000 ft.; this power is, moreover, also available for take-off under tropical conditions since the engine is, in the words of the Bristol company, "by normal standards an engine of about 8,000 h.p.," but the output is torque-limited to 4,000 h.p.

The BE25, it may be recalled, is a "two-spool" engine in which a low-pressure compressor, driven by a three-stage low-pressure turbine, supercharges a high-pressure com-

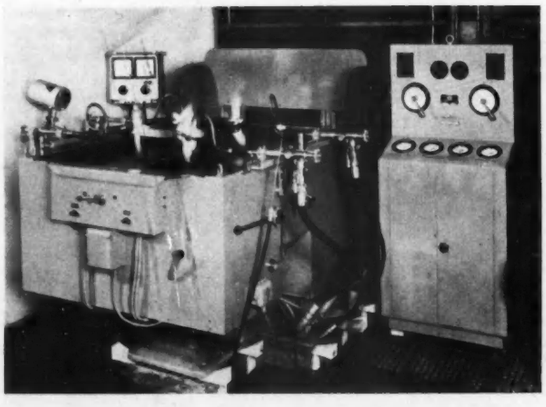


Fig. 2 The gearwheel is heated by the four burners while it spins, and is quenched by being submerged in the tank of oil. Plant is incorporated to cool the oil after quenching.

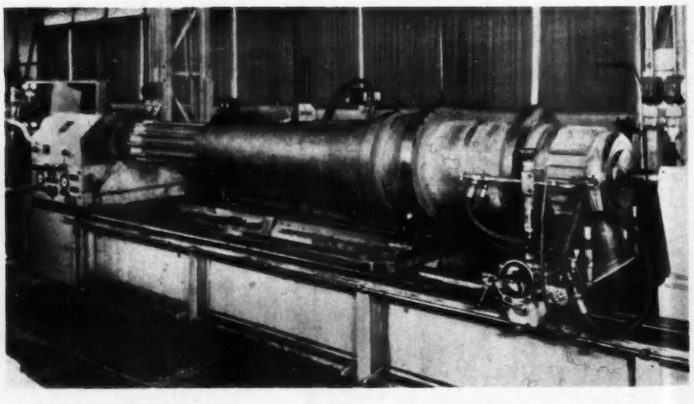


Fig. 3 Universal flame-hardening machine being used to harden splines. Smaller workpieces can be spun while being hardened, and the rate of travel of the burners and quench can be varied to produce the required depth of hardening.

pressor driven by a single-stage turbine. The high-pressure and low-pressure systems are mechanically independent of each other. Owing to the torque limitation, it is possible to employ the same 16-ft. diameter four-blade de Havilland propellers as are fitted on the Proteus power plants in Britannia aircraft now coming off the production line. The propeller is driven from the low-pressure shaft through a two-stage epicyclic gear train also identical with that used on the Proteus.

The twin-spool arrangement allows the use of a high pressure ratio—10 to 1—giving a low fuel consumption. With the advances in engine design during the past few years, the dimensions and weight of the BE25 do not, it is stated, greatly exceed those of the Proteus, although the cruising power available at 30,000 ft. will be nearly twice that of the Proteus.

The " waisting " around the compressor casing makes a convenient space for grouping the accessories. Generally, the electrical accessories are mounted on top of the engine, the fuel control system to the side and the oil system at the bottom. The engine is mounted from four dynamic suspension units focused on the centre of gravity.

★ ★ ★

COOLING HOT-AIR FANS

Checking Heat Flow Along the Shaft

One of the problems that always has to be faced by the designer of hot-air circulating systems is that of conduction of heat along the fan shaft. As long as the temperatures involved are not high, this is not serious, but when they reach the order of 800 deg. F., then action must be taken. For this reason, the Spooner Dryer and Engineering Company, Limited, Moorland Works, Ilkley, Yorkshire, have developed a special coupling for use with their air heaters and dryers. Its introduction between the fan and the driving motor or pulley keeps the shaft temperature at the bearings to a reasonable value without loss of shaft stiffness or balance. An arrangement drawing of the firm's indirect air heater (a typical application for this coupling) is shown in Fig. 1 and details of the coupling itself in Fig. 2.

As will be seen from Fig. 1, the products of combustion impinge directly on the fan and are circulated to the heat exchangers. Products of combustion can escape from the exhaust ports as they are replaced by fresh air entering for combustion. The remainder are recirculated in the system. The fan therefore tends to approach

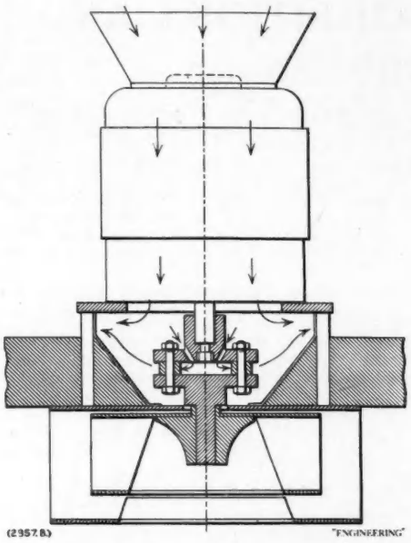


Fig. 2 Cooling coupling fitted between motor and fan. The distance pieces help to circulate the air over the two parts.

the temperature of the burnt gases, and there is a heat flow along the driving spindle. The open coupling dissipates this heat and so allows the bearings to run at a reasonable temperature.

The coupling, shown in Fig. 2 in use with a motor-driven fan, is made of two parts held together by accurately-fitting bolts and distance pieces. In addition, holes are drilled in the centre of the coupling, and the distance pieces are used to form primitive fan blades which circulate air between and around the two parts. This cools the coupling sufficiently to prevent excessive heat from flowing along the driving shaft to the motor bearings. The operation is exactly the same when the fan is belt driven from a pulley. It is possible to use the coupling on both vertical and horizontal fans, but as the overhang is slightly greater than with a solid coupling, it is necessary to ensure that the shaft is strong enough. Accurate machining of the coupling ensures that the balance of the rotating parts is maintained.

Tests have been carried out in which the fan shaft, without runner, was brought up to a red heat and run continuously. The bearings remained cool. In the heat exchange system in Fig. 1, when the products of combustion were at 800 deg. F., the motor bearings rose only 35 deg. F. during a very long period of continuous running. High temperatures are required in this type of exchanger (which has an efficiency of about 90 per cent.) in order to keep its size small. The flame (either oil or gas can be used) only supplies the heat extracted from the primary air by the exchangers as the main bulk of the primary air is recirculated continuously.

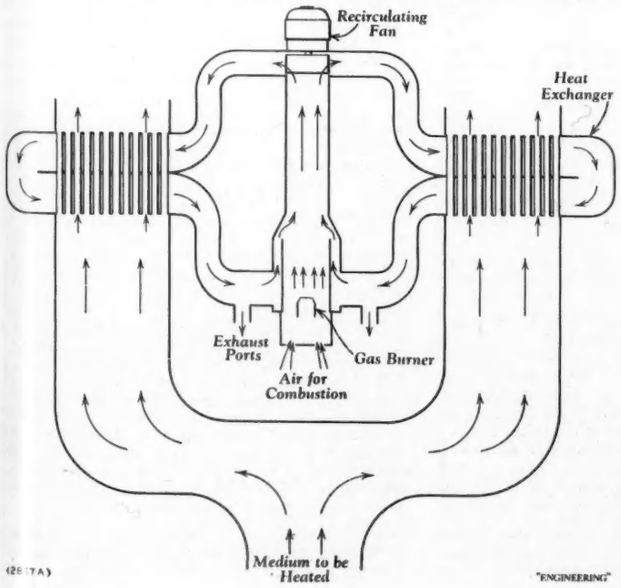


Fig. 1 Arrangement of an indirect heating system. The products of combustion are at about 800 deg. F. at the fan.

★ ★ ★

ENGINEER EQUIPMENT

Display at M.E.X.E.

An unusual " At Home " held recently was that of the Military Engineering Experimental Establishment (MEXE) at Christchurch, Hampshire. At this establishment what is termed " engineer equipment " is developed and tested for use in the Services. The term covers a very large range of items, from bridges to tractors, some of which are designs conceived in the establishment and others standard commercial equipment.

The first item to be demonstrated was a light-alloy assault boat, driven by a detachable outboard motor. This craft has a crew of two and will carry ten infantrymen. The engine was an opposed-piston Coventry Victor model, giving the boat a speed of about six knots when fully loaded or about 15 with only the crew on board. Two of these boats can be fastened stern to stern if a larger craft is required.

Next, an exhibition was given of a new assault bridge which is carried on light-alloy pontoons. This is somewhat similar to the standard Bailey bridge in its method of construction. Each section, consisting of one pontoon, the two side members and the decking, is assembled away from the river and is brought up on a two-wheel trailer, from which it is launched direct into the water. The sections are then coupled together by four pins and the decking levered into place. The end of the bridge is towed out by a tug as each section is added, and the end sections are arranged to tilt with varying water levels, but to lock solid when a vehicle is crossing.

A ferry was the next item that took the stage. Built up from lorry-borne sections, it is propelled in the water by hydraulic jets at each corner. These can be controlled either independently or from a central station. The loading ramps fore and aft can be raised hydraulically to suit the bank height, and can be folded back on to the the main body for transport.

The second phase of the display was devoted to heavy bridging equipment. The visitors were shown, first on a model and then on an actual bridge section, how a standard Bailey bridge is erected. For testing bridge sections, MEXE have designed and built a large testing rig under which bridge sections up to 35 ft. wide, 30 ft. high and of indefinite length can be subjected to loads up to 250 tons downwards or 175 tons upwards. There are two gantries for applying the load and they are rail mounted for positioning. It is hoped to make this rig generally available when the experimental programme is completed.

A task which the Services have had to tackle in recent years is the preparation of airfields and landing strips. Demonstrations of equipment for this formed the third section of the display. A typical soil stabilisation train (the one on view was supplied by Rotary Hoes Limited, with a Road-Marshall tandem roller following) was constructing a pavement 6 in. thick and 6 ft. wide at a speed of about 7 ft. a minute. Methods of soil sampling with a lorry-mounted augur were also shown. At another site, stone-crushing plant, macadamising plant and spreaders were shown in action, together with a variety of other equipment such as bench saws, pumps (one of them driven by a gas-turbine) and water purifiers. Of special use to the Forces were two machines for filling jerrycans: one stationary and the other (of rotary type) mounted on a trailer. The " At Home " was concluded by a " march past " of wheeled and crawler tractors, scrapers, dumpers and motorised graders.

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list appears in the last issue of each month. Events appearing for the first time, and alterations of dates, place, etc., are indicated by an asterisk (*). Particulars of forthcoming exhibitions and conferences not included below may have appeared in ENGINEERING, *March 25, page 386. Organisers are invited to send to the Editor particulars of forthcoming events as soon as arrangements are made.*

BRITISH INDUSTRIES FAIR.—Mon., May 2, to Fri., May 13, at Olympia, London, W.14; and Castle Bromwich, Birmingham. Particulars from British Industries Fair Ltd., Ingersoll House, 9 Kingsway, London, W.C.2. Tel. COVent Garden 1461; or from the general manager, British Industries Fair, 95 New-street, Birmingham, 2. Tel. Midland 5021.

DUBLIN SPRING SHOW AND INDUSTRIES FAIR.—Tues., May 3, to Sat., May 7, at Ballsbridge, Dublin. Apply to the Royal Dublin Society, Ballsbridge, Dublin.

NORTHERN RADIO SHOW.—Wed., May 4, to Sat., May 14, at the City Hall, Manchester. Organised by the Radio Industry Council, 59 Russell-square, London, W.C.1. Tel. MUSeum 6901.

PHOTOGRAPHY AND CINEMA EXHIBITION.—Wed., May 4, to Mon., May 16, in Paris. Organised by the Biennale Internationale de la Photographie et du Cinéma, 116 bis Avenue des Champs-Élysées, Paris.

GERMAN HANDICRAFTS AND TRADE FAIR.—Fri., May 6, to Sun., May 15, at Munich. Organised by the Verein für Handwerks-Ausstellungen und Messen e.V., Theresienhöhe 14, Munich 12, Germany.

*HEATING, VENTILATING AND AIR CONDITIONING CONFERENCE.—Mon., May 9, to Wed., May 11, at the hall of the Fédération Nationale du Bâtiment, 7 Rue La Pérouse, Paris, 16e. Organised by the Institut Technique du Bâtiment et des Travaux Publics, 19 Rue La Pérouse, Paris, 16e.

ELECTRIC HEATING CONFERENCE.—Tues. and Wed., May 10 and 11, at Chicago, Ill., U.S.A. Apply to American Institute of Electrical Engineers, 33 West 39th-street, New York 18.

ACHEMA XI GERMAN CHEMICAL APPARATUS CONGRESS AND EXHIBITION.—Sat., May 14, to Sun., May 22, at Frankfurt-on-Main. Organised by DECHEMA Deutsche Gesellschaft für chemisches Apparatewesen, Rheingau-Allee 25, Frankfurt-on-Main.

PARIS TRADE FAIR (44TH).—Sat., May 14, to Mon., May 30. *Agent:* Mrs. M. Hyde-Joucla, 14 Rugby Chambers, Rugby-street, London, W.C.1. Tel. CHAncery 6794.

NEW YORK TRADE FAIR.—Sun., May 15, to Thurs., May 19, at the Armory, 25th-street, Manhattan, New York. Organised by International Trade Shows, 545 Fifth-avenue, New York.

*SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—Thurs. and Fri., May 19 and 20, at Philadelphia, Pa., U.S.A. Apply to the Society, 74 Trinity-place, New York 6.

*NEW TECHNIQUES FOR OLD.—Fri. and Sat., May 20 and 21, at Turnberry, Ayrshire. Fourth Scottish conference organised by the British Institute of Management, 8 Hill-street, London, W.1. Tel. GROsvenor 6000.

INTERNAL COMBUSTION ENGINE CONGRESS, INTERNATIONAL.—"COLLOQUY 1955—THE HAGUE."—Mon., May 23, to Sat., May 28, at Scheveningen, Holland. Organised by the Congrès International des Moteurs à Combustion Interne, 11 Avenue Hoche, Paris, 8e. Inquiries in Britain may be sent to the secretary of the British National Committee, c/o The British Internal Combustion Engine Manufacturers' Association, 6 Grafton-street, London, W.1. Tel. HYDe Park 5107. See ENGINEERING, September 24, 1954, page 389.

*ELECTRONICS COURSE, HARWELL.—Mon., May 23, to Thurs., May 26. Apply to Electronics Division, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

MEDITERRANEAN FAIR (TENTH).—Wed., May 25, to Fri., June 10, at Palermo. Organised by Fiera del Mediterrano, Piazza Generale Cascino, Palermo.

PADUA INTERNATIONAL FAIR AND PACKAGING SALON.—Sun., May 29, to Mon., June 13, at Padua. Organised by Fiera di Padova, 59 Via N. Tommaseo, Padua, Italy.

CANADIAN INTERNATIONAL TRADE FAIR (EIGHTH).—Mon., May 30, to Fri., June 10, at Toronto. Further information from Miss M. A. Armstrong, Canadian Government Exhibition Commission, Canada House, Trafalgar-square, London, S.W.1. Tel. WHItehall 8701.

LARGE DAMS (FIFTH CONGRESS OF THE INTERNATIONAL COMMISSION).—Tues., May 31, to Sat., June 4, in Paris. Apply to the British National Committee, 201–202 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 3966. See ENGINEERING, April 2, 1954, page 448; October 22, 1954, page 520; and Mar. 4, page 262.

*METALLURGICAL SOCIETIES' JOINT MEETING IN EUROPE.—Wed., June 1, to Tues., June 7, in London and British centres; Thurs., June 9, to Sun., June 12, in Düsseldorf, Germany; Mon., June 13, in Liége, Belgium; and Tues., June 14, to Sat., June 18, in Paris and French centres. Open to members of British, West European and American metallurgical societies. Apply to the Iron and Steel Institute, 4 Grosvenor-gardens, London, S.W.1. Tel. SLOane 0061. See ENGINEERING, April 15, page 459.

*AVIATION DISPLAY AND STATIC EXHIBITION.—Fri., June 10, to Sun., June 19, at le Bourget Airport. Organised by the Union Syndicale des Industries Aéronautiques, 4 Rue Galilée, Paris, 16e.

BUILDING AND PUBLIC WORKS MATERIALS AND EQUIPMENT EXHIBITION (FIRST INTERNATIONAL).—Sat., June 25, to Sun., July 10, at Domaine National de St. Cloud, Paris. Exhibition offices: 29 Rue Cambon, Paris.

*AMERICAN SOCIETY FOR TESTING MATERIALS.—Sun., June 26, to Fri., July 1, at Atlantic City, N.J., U.S.A. Annual meeting, arranged by the Society, 1916 Race-street, Philadelphia 3, Pa., U.S.A.

BRITISH INSTRUMENT INDUSTRIES EXHIBITION.—Tues., June 28, to Sat., July 9, at Earl's Court, London, S.W.5. Organised by F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 0568.

GREAT YORKSHIRE AGRICULTURAL SHOW.—Tues., July 12, to Thurs., July 14, at Harrogate, Yorkshire. Organised by the Yorkshire Agricultural Society, Cliftonfield, Shipton-road, York. Tel. York 3102.

DRY CLEANING, DYEING AND ALLIED TRADES EXHIBITION.—Fri., July 15, to Sun., July 24, at the Ausstellungspark, Munich. Organised by the Internationale Fachausstellung Chemisch-Reinigung und Färberei, Geschäftsstelle, Munich 12, Germany.

*PURE AND APPLIED CHEMISTRY, INTERNATIONAL CONGRESS OF.—Thurs., July 21, to Wed., July 27, at Zürich. Organised by the International Union of Pure and Applied Chemistry, the 18th conference of which will be held, also at Zürich, from Wed., July 20, to Thurs., July 28. Apply to the Chemical Society, Burlington House, Piccadilly, London, W.1. Tel. REGent 0675.

SKANE (SWEDISH NATIONAL) FAIR (37TH).—Sat., July 23, to Sun., July 31, at Malmö. Organised by Skanemassan Kommissariat, Stora Nygatan 15, Malmö, Sweden.

AUSTRIAN INTERNATIONAL EXPORT AND TRADE FAIR.—Fri., July 29, to Sun., Aug. 7, at Dornbirn, Austria. Organised by Export-U Mustermesse G.m.b.H., Dornbirn. *Agents:* British Austrian Chamber of Commerce, 29 Dorset-square, London, N.W.1. Tel. PADdington 7646.

DUBLIN HORSE SHOW AND INDUSTRIAL FAIR.—Tues., Aug. 2, to Sat., Aug. 6, at Ballsbridge, Dublin. Organised by the Royal Dublin Society, Ballsbridge, Dublin.

MOTOR INDUSTRY SUMMER SCHOOL.—Sat., Aug. 20, to Sat., Aug. 27, at Corpus Christi College, Cambridge. Organised by the Institute of the Motor Industry, 40 Queen's Gate, London, S.W.7. Tel. WEStern 0915. See ENGINEERING, December 10, 1954, page 772.

NATIONAL RADIO SHOW.—Wed., Aug. 24, to Sat., Sept. 3, at Earl's Court, London, S.W.5. Organised by the Radio Industry Council, 59 Russell-square, London, W.C.1. Tel. MUSeum 6901.

GERMAN RADIO, GRAMOPHONE AND TELEVISION EXHIBITION.—Fri., Aug. 26, to Sun., Sept. 4, at Düsseldorf. Agents: John E. Buck & Co., 47 Brewer-street, London, W.1. Tel. GERrard 7576.

PRESTRESSING, CONFERENCE ON.—Mon., Aug. 29, to Fri., Sept. 2, at the Royal Tropical Institute, Mauritskade 63, Amsterdam 0, Holland. Organised by the Fédération Internationale de la Précontrainte, Groningsestraat 15, The Hague. See ENGINEERING, December 17, 1954, page 782.

BRITISH ASSOCIATION MEETING.—Wed., Aug. 31, to Wed., Sept. 7., at Bristol. Apply to the secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1. Tel. REGent 2109. See ENGINEERING, February 11, page 168.

ENGINEERING, MARINE, WELDING AND FOUNDRY TRADES EXHIBITION (20TH).—Thurs., Sept. 1 to Thurs., Sept. 15, at Olympia, London, W.14. Organised by F. W. Bridges and Sons, Ltd., Grand Buildings, London, W.C.2. Tel. WHItehall 0568.

*STRASBOURG EUROPEAN FAIR.—Sat., Sept. 3. to Sun., Sept. 18, at Wacken, Strasbourg, France. *Agent:* R. C. Liebman, 178 Fleet-street, London, E.C.4. Tel. CITy 5889.

LEIPZIG INTERNATIONAL FAIR.—Autumn Fair: Sun., Sept. 4, to Fri., Sept. 9. Apply to Leipzig Fair Agency, 127 Oxford-street, London, W.1. Tel. GERrard 0357.

GHENT INTERNATIONAL FAIR, INCLUDING PRINTING AND PUBLISHING TRADES EXHIBITION and QUINQUENNIAL EXHIBITION OF SCIENTIFIC AND INDUSTRIAL LABORATORY EQUIPMENT.—Sat., Sept. 10, to Sun., Sept. 25, at Ghent, Belgium. *Agents:* S. R. Tippett & Co., Ltd., 110 Cannon-street, London, E.C.4. Tel. MANsion House 4500.

INSTRUMENT EXHIBITION AND CONFERENCE (10TH ANNUAL).—Mon., Sept. 12, to Fri., Sept. 16, at the Shrine Exposition Hall, Los Angeles. Organised by the Instrument Society of America, 3443 South Hill-street, Los Angeles 7, California, U.S.A.

COMPUTING MACHINERY CONGRESS.—Wed., Sept. 14, to Fri., Sept. 16, at the Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, U.S.A. Apply to Association for Computing Machinery, Building 13–2, Camden 2, New Jersey, U.S.A.

IRON AND STEEL ENGINEERS, ASSOCIATION OF (AMERICAN).—*Annual Convention:* Mon., Sept. 26, to Thurs., Sept. 29, at Chicago. Apply to Association of Iron and Steel Engineers, Empire Building, Pittsburg 22, Pa., U.S.A.

*NATIONAL SMOKE ABATEMENT SOCIETY'S ANNUAL CONFERENCE.—Wed., Sept. 28, to Fri., Sept. 30, at Bournemouth. Apply to Society's offices: 30 Grosvenor-place, London, S.W.1. Tel. SLOane 6301.

TURIN INTERNATIONAL TECHNICAL EXHIBITION (FIFTH), also 7TH AGRICULTURAL ENGINEERING EXHIBITION and 15TH ENGINEERING EXHIBITION.—Wed., Sept. 28, to Sun., Oct. 9, in Turin. Exhibition offices: Via Massena, Turin, Italy.

ALL-BRITISH TRADE FAIR.—Thurs., Sept. 29, to Sun., Oct. 16, in the Tivoli Gardens and the Forum, Copenhagen, Denmark. Inquiries to the British Overseas Fairs, Ltd., 21 Tothill-street, London, S.W.1. Tel. WHItehall 6711. See ENGINEERING, July 16, 1954, page 69.

GERMAN PLASTICS INDUSTRY.—Sat., Oct. 8, to Sun., Oct. 16, at Düsseldorf, Germany. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Düsseldorf. *Agents:* John E. Buck & Co., 47 Brewer-street, London, W.1. Tel. GERrard 7576.

*AUTOMATION EXPOSITION (SECOND INTERNATIONAL).—Mon., Nov. 14, to Thurs., Nov. 17, at the Navy Pier, Chicago. Organised by Richard Rimbach Associates, 845 Ridge-avenue, Pittsburg 12, Pa., U.S.A.

*CHICAGO EXPOSITION OF POWER AND MECHANICAL ENGINEERING.—Mon., Nov. 14, to Fri., Nov. 18, at the Coliseum, Chicago, Ill., U.S.A., under the auspices of the American Society of Mechanical Engineers. Apply to the International Exposition Co., 480 Lexington-avenue, New York 17, U.S.A.

*DOCUMENTATION OF APPLIED CHEMISTRY CONGRESS.—Tues., Nov. 22, to Fri., Nov. 25, at the Institut Français du Royaume Uni, Queensberry-place, London, S.W.7. Apply to the International Congress on Documentation of Applied Chemistry, 56 Victoria-street, London, S.W.1. Tel. VICtoria 5974.

*CHEMICAL INDUSTRIES EXPOSITION.—Mon., Dec. 5, to Fri., Dec. 9, at the Commercial Museum and Convention Hall, Philadelphia, Pa., U.S.A. Organised by the International Exposition Co., 480 Lexington-avenue, New York 17.

*ALUMINIUM IN SHIPBUILDING.—Wed. and Thurs., Dec. 7 and 8, at 10 Upper Belgrave-street, London, S.W.1. Joint symposium on "Use and Welding of Aluminium in Shipbuilding," organised by the Institute of Welding, the Institution of Naval Architects, the British Shipbuilding Research Association, the British Welding Research Association and the Aluminium Development Association. Apply to the secretary, Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. Tel. SLOane 9851.

Labour Notes

NEW WAGE CLAIMS BY ENGINEERING EMPLOYEES

It is no new event for requests for higher wages to figure prominently on the agendas of the annual meetings of British trade unions, but the number of such proposals presented for consideration at this year's annual meeting of the national committee of the Amalgamated Engineering Union appeared to be greater than usual.

The agitation seemed to be the more noteworthy in that it was only last month that employees in the engineering and shipbuilding group of industries received increases in their basic wage rates, ranging from 8s. a week more for labourers to 11*s.* a week extra for skilled men.

Although many of the new demands laid before the conference referred to claims by particular sections of these industries, there were about a dozen resolutions which were applicable to all employees.

The most spectacular of these motions was a demand from Scottish members of the union that the national executive committee should be instructed to ask the employers for a basic wage of £10 10*s.* a week for provincial employees. As the existing rate for adult male engineering workers outside London is £7 15*s.* 10*d.* a week, this was equivalent to requesting an increase of £2 14*s.* 2*d.*

WOMEN'S WAGES

It is considered that the increases granted last month to male engineering employees will cost firms engaged in the engineering industry and ancillary trades between £65 and £70 millions a year. To concede the demand of the union's Scottish members in full would mean the addition of a further £350 million or so to the industry's annual wage bill.

In the main, the resolutions on wages ranged from requests for "substantial increases" in basic rates to demands for specific amounts. There were several claims for an additional 15*s.* a week all-round and two others for an extra 20*s.* a week for everyone.

Many branches asked that, in future, all wage increases should be payable from the date when the demands were first submitted to the employers and that the union should insist on the carrying out of this stipulation as a condition of the settlement of the claims. It was considered that such an arrangement would prevent negotiations being unduly protracted.

One motion suggested that if the claim of women employees to be paid the same rate as adult male labourers were unsuccessful, a strike ballot should be taken by women members and that, should a strike take place, there should be a levy on all adult men belonging to the union.

The conference, which is being held at Blackpool, opened last Monday and, in addition to other business, is engaged on a quinquennial examination of the union's rules.

DELAYS IN SHIPBUILDING

Trade-union practices in British shipyards were criticised at the annual luncheon of the Norwegian Chamber of Commerce in London, which was held in London last Friday.

The President of the Chamber, Mr. Haakon Christophersen, attributed to these practices some of the blame for the high costs and long-term delivery dates at present in force in the British shipbuilding industry. He said that, although 73 contracts for new ships had been placed by Norwegian shipowners in various countries since October 12 last year, none had been given to firms in the United Kingdom.

Shipowners in Norway were well aware of the fact that nowhere could they have ships better built than in the United Kingdom. It was, accordingly, with great regret that they were compelled to place their orders elsewhere, where prices were not so high and where delivery dates were much shorter.

British shipbuilding firms were fully cognisant of the position and, Mr. Christophersen said, he felt sure that they were doing everything possible to prevent further increases in prices. They were, however, handicapped by the labour position in the industry. The number of unions involved was legion and the lines of demarcation between the different jobs allowed to be undertaken by the various trade-union members were carried, only too often, to almost absurd extremes.

This situation, he felt, was a great impediment to the industry when competing for contracts with shipyards in other countries.

UNION DEMARCATION DISPUTE

The committee recently set up by the Minister of Labour to investigate the difficulties which have arisen in the gas industry, as a result of the claim of the Plumbing Trades Union to negotiate on behalf of its members employed on gas-distribution work, issued their report on April 21.

In general, the committee's findings are in agreement with the contentions of the Gas Council. They consider, as the Council does, that it would be impracticable to establish separate negotiating machinery to meet the requirements of the Plumbing Trades Union.

Instead, the committee suggest that the union should be represented on the National Joint Industrial Council for the Gas Industry, and on Area Gas Industrial Councils, in those areas in which its numerical strength is such as to justify such representation. The committee recommend that the Plumbing Trades Union and the other union catering for employees in the gas industry, the National Union of General and Municipal Workers, should mutually agree to respect the existing position of the other body, in regard to the recruitment of new members.

The majority of gas fitters are members of the National Union of General and Municipal Workers, but a substantial number belong to the Plumbing Trades Union.

RAILWAY-STRIKE OUTLOOK

There was little sign, at the time of going to press, of any improvement in the railway-dispute position. By Monday evening last, many branches of the Associated Society of Locomotive Engineers and Firemen had formally registered their support of the decision of the union's executive committee to call a strike of footplate men as from midnight on Sunday next.

The men are asking for an additional increase of 8*s.* a week in order to restore their financial advantage over railwaymen employed in the conciliation grades. The union announced last Saturday that its annual delegate conference, which was due to have been opened in London on May 17, had been cancelled.

Conciliation officials of the Ministry of Labour and representatives of the Trades Union Congress took part in discussions last week, but without securing any apparent improvement in the situation. It was stated during the week-end that there was little likelihood of official intervention in the dispute by the Ministry, at any rate for the time being, as such intervention would be likely to weaken existing negotiating arrangements in the industry, which had been in existence since 1935, and had hitherto achieved good results.

Mr. W. P. Allen, labour relations adviser to the British Transport Commission, stated on April 23 that although nearly one-third of the footplate men were employed in shunting and could not earn much above the basic rates, drivers on long-distance trains received more than the maximum rate of £9 15*s.* a week. Average earnings of the 80,000 footplate men were between £12 and £13 a week.

The executive committee of the National Union of Railwaymen decided last Monday to inform their members of the other union's dispute with the Commission and to instruct them to work normally in the event of a strike, but not to perform work which would usually be done by members of the A.S.L.E.F. This implies that trains operated by N.U.R. members would run normally.

ANNUAL REPORT OF THE B.E.A.M.A.

A Record of Progress

The forty-fourth annual report for the year ended March 31, 1955, of the British Electrical and Allied Manufacturers Association, which was presented to members at the annual general meeting on Thursday, April 21, forms a valuable record of progress in a great industry and is indicative of a liveliness which, it is to be hoped, will continue to exert a beneficial influence on the fortunes of the country. This influence, as the retiring chairman, Mr. D. D. Walker, has pointed out, is not a little due to the spirit of voluntary co-operation which exists among its members; a spirit which will have increasingly to provide inspiration if conditions become more difficult.

AN OPTIMISTIC KEYNOTE

As it is, the keynote of the report is still optimistic. At the end of 1954, 670,000 workers were employed in electrical manufacturing, or 51,400 more than at the end of the previous year. This increased recruitment was evident in nearly every branch, although the most significant expansion was, perhaps naturally, in the fields of domestic appliances, equipment for motor vehicles and electronic, radio and television apparatus. The total number employed now accounts for 7¼ per cent. of the labour force in all the manufacturing industries in the United Kingdom.

In this connection, however, not only quantity but quality is necessary if progress is to be maintained. That this is recognised is shown by the pressing demands by electrical producers for increasing skills and techniques; and for a heavier expenditure on training and upgrading. In this respect the Education Committee of the Association has played an effective part.

Perhaps the best idea of the importance of the industry in the national economy is given by the statement that it provides no less than 20 per cent. of all British exports. In 1954 the value of these products was £218 million, which was only slightly less than the record figure of £220 million in 1952. Exports of generators advanced by £1 million and of steam and water turbines by almost as much, while the figure for electric locomotives was £6 million, which was nearly double the £3·3 million recorded in 1952. A further welcome feature was the improvement in domestic appliance exports, which rose by nearly 22 per cent., or by £6·5 million, especially as such exports are notably vulnerable to fluctuations in the economies of oversea markets. This success, it is pointed out, is undoubtedly linked with the expansion in sales in the home market, a highly competitive field in which the influences of an orderly and sustained production programme cannot be over-emphasised. Other progress at home was also satisfactory.

COURAGE AND FARSIGHTEDNESS

Attention is called to the "two courageous and far sighted programmes" which were announced by the Government during the year, namely those dealing with the use of atomic energy and with the modernisation and electrification of our railway system. Both these two great plans will, it is pointed out, provide electrical manufacturers with further opportunities.

The magnitude of the plan for the re-equipment and electrification of the railways has raised some doubt as to the ability of the industry to meet the demands that will consequently fall upon it. It is, however, argued in the report that the work that has been carried out in the field of railway electrification overseas proves that our manufacturers have the necessary skill and experience, while as regards capacity the industry is far from being stretched to its limits.

TRADE PRACTICES INQUIRY

In addition to hire purchase regulations, the report points out that the sale of electrical appli-

ances may be affected by the Trade Practices Inquiry of the Monopolies Commission. While the Association is not concerned in this inquiry, resale price maintenance being outside its activities, it is felt that it may be useful to restate its position in regard to prices.

The British Electrical and Allied Manufacturers Association, it is pointed out, is a non-profit making association of manufacturers functioning through the voluntary co-operation of its members. It is precluded from acting in any way that would make it a Trade Union. It cannot therefore engage in "price-fixing." The result is that member-firms and others interested in the manufacture of particular products have organised themselves into trade groups. Membership of these groups is open to any electrical manufacturer, but is not essential to membership of the Association.

Dealing with matters more of detail than general policy the report records many instances of co-operation with other bodies. For instance, the conditions on international contract practices in engineering, which were published by a working party of the United Nations Economic Commission in 1953, contained certain features which were repugnant to current practice in eastern European countries. It was therefore decided to issue an alternative version of the existing "non-erection" conditions. It is hoped that this will serve as a reasonably satisfactory basis for a large number of engineering contracts with eastern European countries.

To perform more efficiently its primary function of providing influential readers abroad with an authoritative review of British developments in electrical equipment, the appearance of the *Beama Journal* has been improved without changing its editorial policy; and the result has been favourably received. A *Bulletin*, which incorporates the previous *News Sheet* and *Export Bulletin* as well as the *BEAMA Record of Price Changes* is now published twice a month.

At the annual general meeting Viscount Chandos, chairman of Associated Electrical Industries, Limited, was elected president of the Association for 1955-56; and Mr. E. H. Ball, managing director, British Thomson-Houston Company, Limited, and Mr. J. O. Knowles, chairman and Joint Managing Director, Brookhirst Switchgear, Limited, chairman and vice-chairman, respectively.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Engineering in the West Indies," by H. Clifton. West London Branch. 134 King-street, Hammersmith, W.6. Tues., May 3, 7.30 p.m.
ILFORD
"Thermal Plastic Cables," by R. J. Smith. North-East London Branch. Angel Hotel, Ilford. Mon., May 2, 8 p.m.
LEEDS
"Industrial Applications of Photography," by Dr. S. O. Rawling. Leeds Branch. Grand Northern Hotel, Leeds. Mon., May 2, 7.30 p.m.
LIVERPOOL
Various short papers. Liverpool Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Fri., May 6, 8 p.m.
PORTSMOUTH
"Fluorescent Applications," by A. Jones. Portsmouth Branch. 598 Commercial-road, Mile End. Portsmouth. Tues., May 3, 7.30 p.m.
PRESTON
"Relays and Instruments," by E. W. Semmens. Preston Branch. Preston Chamber of Commerce, 49A Fishergate, Preston. Thurs., May 5, 7.30 p.m.
WEMBLEY
"Maintenance of Contactors and Control Gear," by W. H. Jones. North-West London Branch. Century Hotel, Forty-avenue, Wembley Park. Fri., May 6, 8.15 p.m.

Chemical Society

LONDON
General Meeting. Thurs., May 5, 7.30 p.m.
EXETER
"Acetylene-Allene Chemistry," by Professor E. R. H. Jones. Exeter Branch. Washington Singer Laboratories, Exeter. Fri., May 6, 5 p.m.
SOUTHAMPTON
"Kinetics of Some Organic Reactions," by R. P. Bell. Southampton Branch. Chemistry Department, The University, Southampton. Fri., May 6, 5 p.m.

Illuminating Engineering Society

LONDON
Annual General Meeting. "Illuminated Chateaux of France," by J. J. Chappat. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., May 10, 6 p.m.
LIVERPOOL
Annual General Meeting. "A Survey of the Society's Activities," by the President, E. C. Lennox. Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Mon., May 2, 6.30 p.m.
NOTTINGHAM
Annual General Meeting. Nottingham Centre. Offices of the East Midlands Electricity Board, Smithy-row, Nottingham. Thurs., May 5, 6 p.m.

Incorporated Plant Engineers

LONDON
"Heat Pumps and Refrigeration," by Sir Oliver Lyle. London Branch. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., May 3, 7 p.m.
LEICESTER
"Selection of Electric Motors," by K. Broom (with film). Leicester Branch. Leicester College of Art and Technology, The Newarkes, Leicester. Wed., May 4, 6.30 p.m.
MANCHESTER
"Notes on the Statutory Requirements of Steam and Pressure Vessels and Machinery," by W. H. Mills. Manchester Branch. Engineers' Club, Alber-square, Manchester. Tues., May 10, 7.15 p.m.
NOTTINGHAM
Film Evening. East Midlands Branch. County Hotel, Nottingham. Wed., May 11, 7 p.m.
PETERBOROUGH
Open Meeting. Peterborough Branch. Campbell Hotel, Bridge-street, Peterborough. Thurs., May 5, 7.30 p.m.
SOUTHAMPTON
Film Evening. Southampton Branch. Polygon Hotel, Southampton. Wed., May 4, 7.30 p.m.

Institute of British Foundrymen

COVENTRY
"Some Aspects of Cupola Operation," by W. H. Bamford. Coventry Section. Coventry Technical College, Coventry. Tues., May 10, 7.30 p.m.

Institute of Fuel

CARDIFF
Annual General Meeting. South Wales Section. South Wales Institute of Engineers, Park-place, Cardiff. Fri., May 6, 6 p.m.

Institute of Marine Engineers

LONDON
Symposium on "Advanced Machinery Installations Designed for the Maximum Saving in Weight and Space." Joint Meeting with the Institution of Naval Architects. Tues., May 10, 5.30 p.m.

Institute of Metals

LONDON
"Statistical Methods in Metallurgy," by Dr. U. R. Evans. London Local Section. Joint Meeting with London Industrial Applications Group of the Royal Statistical Society. E.L.M.A. Lighting Service Bureau, 2 Savoy-hill, Strand, W.C.2. Fri., May 6, 6 p.m.

Institute of Petroleum

LONDON
"Evaporation Losses from Petrol Storage Tanks in the United Kingdom," by E. H. Walker, R. M. Eltringham and A. Puttick. Wed., May 11, 5.30 p.m.

Institute of Refrigeration

LONDON
"Some Problems in the Design of Household Refrigerators," by N. F. T. Saunders. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., May 5, 5.30 p.m.

Institute of Road Transport Engineers

NOTTINGHAM
Annual General Meeting. East Midlands Centre. Mechanics' Institute, Nottingham. Wed., May 4, 7.30 p.m.

Institution of Chemical Engineers

LONDON
"Plant Management," by P. M. Shaw. London Graduates' and Students' Section. Caxton Hall, Westminster, S.W.1. Fri., May 6, 6.30 p.m.

Institution of Civil Engineers

LONDON
"The Application of Prestressed Concrete to Water-Supply and Drainage," by Professor R. H. Evans. Public Health Engineering Division. Tues., May 3, 5.30 p.m.
First Graham Clark Lecture on "The Engineer's Contribution to the Conservation of Natural Resources," by Sir Harold Hartley. Joint Meeting with the Institutions of Electrical and Mechanical Engineers. Wed., May 4, 5.30 p.m.
"Some Notes on the Half-Through Type Plate Girder Railway Bridge," by P. S. A. Berridge and F. M. Easton. Railway Engineering Division. Tues., May 10, 5.30 p.m.
BIRMINGHAM
Annual General Meeting. Midlands Association. James Watt Memorial Institute, Great Charles-street, Birmingham. Thurs., May 12, 6 p.m.

Institution of Electrical Engineers

LONDON
"A Simple Introduction to Telegraph Codes," by H. V. Higgitt. Radio Section. Mon., May 2, 5.30 p.m.
"Medical Uses of Radioactive Isotopes," by Professor W. V. Mayneord. Measurements Section. Tues., May 3, 5.30 p.m.
First Graham Clark Lecture on "The Engineer's Contribution to the Conservation of Natural Resources," by Sir Harold Hartley. Joint Meeting with Institutions of Civil and Mechanical Engineers. Institution of Civil Engineers, Great George-street, S.W.1. Wed., May 4, 5.30 p.m.
"The Electrical Activity of the Brain," by Dr. W. Grey Walter. Utilization Section. Thurs., May 5, 5.30 p.m.
Symposium on "Transistors and Other Semi-Conductor Devices," including "Junction Transistor Noise in the Frequency Range 7 to 50 Kc/s," by W. L. Stephenson; and "Noise in Silicon Microwave Diodes," by G. R. Nicoll. Radio Section. Wed., May 11, 5.30 p.m.
Discussion on "Image Intensification in Radiology," opened by Dr. W. J. Oosterkamp and Dr. G. M. Ardran. Thurs., May 12, 5.30 p.m.
LEEDS
Annual General Meeting and lecture on a non-electrical subject. North Midland Centre. Offices of the British Electrical Authority, 1 Whitehall-road, Leeds. Tues., May 3, 6.15 p.m.
MANCHESTER
"An Attracted-Disc Absolute Voltmeter," by G. W. Bowdler. Annual General Meeting. North-Western Centre. Engineers' Club, Albert-square, Manchester. Tues., May 3, 6.15 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
Annual General Meeting. North-East Branch. Crown Hotel, Clayton-street, Newcastle-upon-Tyne. Fri., May 13, 6.15 p.m.

Institution of Locomotive Engineers

LONDON
"Operation and Running Maintenance of Locomotives on the Nigerian Railway," by F. H. Jaekel. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., May 4, 5.30 p.m. (Alteration of date.)

Institution of Mechanical Engineers

LONDON
"The Reversible Bending of Turbine Shafts with Temperature," by A. Barker and Dr. F. W. Jones. Applied Mechanics Group. Fri., May 6, 5.30 p.m.
"An Investigation of Hydraulic Lock," by J. Manhajm and D. C. Sweeney. Hydraulics Group. Fri., May 13, 5.30 p.m.

Institution of Naval Architects

LONDON
Symposium on "Advanced Machinery Installations Designed for the Maximum Saving in Weight and Space." Joint Meeting with the Institute of Marine Engineers. 85 The Minories, E.C.3. Tues., May 10, 5.30 p.m.

Institution of Sanitary Engineers

LONDON
Open Meeting. Caxton Hall, Westminster, S.W.1. Thurs., May 5, 6 p.m.

Royal Aeronautical Society

LONDON
"Plastic Structures," by G. C. Hulbert. Section Lecture. Tues., May 3, 7 p.m.
"Technical Aspects of Supersonic Aircraft Design," by E. J. Catchpole and W. J. Eggington. London Graduates' and Students' Section. Wed., May 4, 7.30 p.m.

Royal Institution

LONDON
"Fast Reactions in Solids and the Birth and Growth of Explosions," by Dr. F. P. Bowden. Fri., May 6, 9 p.m.

The Royal Society

LONDON
Discussion on "Magneto-Hydrodynamics," to be opened by Sir Edward Bullard. Thurs., May 5, 10.30 a.m.
Film on "Some Research Activities of the Istituto Superiore di Sanità, Rome," with introductory address by the director-general, Professor D. Marotta; and "Some Recent Advances in Carbohydrate Metabolism," by E. B. Chain. Thurs., May 12, 4.30 p.m.

Royal Society of Arts

LONDON
Trueman Wood Lecture on "New Ways of Flying," by Major Oliver Stewart. Wed., May 4, 2.30 p.m.
"The Planning of Roads," by E. W. H. Vallis. Wed., May 11, 2.30 p.m.

Royal Statistical Society

LONDON
"Statistical Methods in Metallurgy," by Dr. U. R. Evans. London Industrial Applications Group. Joint Meeting with the London Local Section of the Institute of Metals. E.L.M.A. Lighting Service Bureau, 2 Savoy-hill, W.C.2. Fri., May 6, 6 p.m.

Women's Engineering Society

LONDON
"Heavy Civil-Engineering Works," by C. K. Haswell. Hope House, Great Smith-street, S.W.1. Thurs., May 12, 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Metals, 4 Grosvenor-gardens, London, S.W.1. (SLOane 6233.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Refrigeration, Dalmeny House, Monument-street, London, E.C.3. (MINcing Lane 6851.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of Chemical Engineers, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Locomotive Engineers, 28 Victoria-street, London, S.W.1. (ABBey 6672.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. (SLOane 4622.)
Institution of Sanitary Engineers, 118 Victoria-street, London, S.W.1. (VICtoria 3017.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Royal Statistical Society, 21 Bentinck-street, London, W.1. (WELbeck 7638.)
Women's Engineering Society, 45 Eastcastle-street, London, W.1. (LANgham 9571.)